THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 61 Thursday, September 28, 1939 No. 1206

PUBLISHED WEEKLY

Subscription Terms: 17s. 6d. per annum.
Foreign and Colonial: 20s. per annum.
All Subscriptions are payable in advance.

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.

EMERGENCY ADDRESS
to which all communications should be sent until further notice:—
3, Amersham Road, HIGH WYCOMBE, Bucks.
Telegraphic Address: "Zacatecas, High Wycombe."
Telephone: HIGH WYCOMBE 1792 (3 lines).

OFFICIAL ORGAN OF
The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1938-39
W. B. Lake, J.P., Lake and Elliot, Limited, Braintree, Essex.

LIST OF SECRETARIES—
General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham, 3.
East Midlands: B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.
Lancashire (pro tem): A. Boyes, 377, Liverpool Road, Patricroft, Manchester.
London: G. W. Daglish, Stewarts & Lloyds, Limited, Winchester House, Old Broad Street, E.C.2
Middlesbrough: G. P. Kirk, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.
Newcastle-upon-Tyne: C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Sheffield: T. R. Walker, M.A., F.I.C., 11, Broomgrove Crescent, Sheffield, 10.
Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Newport.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Ecclesshill, Bradford.
South Africa: F. C. Williams, Mutual Buildings, Corner of Harrison and Commissioner Streets
Bristol: A. Hares, Park Crescent, 648, Stapleton Road, Bristol, 5.
Burnley: H. Buckley, Ellsmere, Norfolk Avenue, Burnley, Lancs.
East Anglian: J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.
Falkirk: T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.
Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President: Sir Harold Hartley, F.R.S., Euston Station, London, W.C.1.
Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Mrs. Kenneth Hill, Letchworth Hall Hotel, Letchworth, Herts.

Foundry Trades' Equipment and Supplies Association

President: G. E. France, August's Limited, Thorn Tree Works, Halifax.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275 Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
Concrete Co-operation	209
Institute of British Foundrymen	210
War Risks Insurance	210
Random Shots	210
Co-operation between Designer and Foundryman	211
Book Review	213
Resistance of High-Silicon Malleable Iron to Drilling	213
Notes on Steel Foundry Practice	214
The Renaissance of the Steel Casting and the Rôle of the Metallurgist	216
Efficiency in Crucible Melting	217
Gating and Feeding in Steel-Foundry Practice	218
Patents and Trade Marks	218
Making and Application of Industrial Time and Motion Studies	219
Publications Received	220
The Week's News in Brief	222
Trade Talk	222
Obituary	222
Reports and Dividends	222
Metallurgical Puzzle	222
Raw Material Markets	224

Concrete Co-operation

At intervals during the last twenty years, foundry executives, either in Presidential Addresses, Papers to technical societies or in discussion, have been making pleas for the co-operation between the drawing office, pattern-shop and foundry. Nobody in the United Kingdom or, so far as we remember, in the United States, has had the courage to suggest actual enforcement of co-operation by the issue of a specification which would oblige designers to conform (where possible) to certain rules, enunciated with the object of minimising foundry difficulties. In France, however, a start has been made. According to Mr. André, a translation of whose Paper to the last French foundry conference appears elsewhere in this issue, a brochure sponsored by the French shipbuilding employers' federation has every appearance of being suitable for forming the basis of a specification for the design of castings.

We think it will be generally agreed that the composition of such a specification is bristling with difficulties. Designers rightly would object to being shackled by suggestions solely existing for the benefit of the foundry; they would point to cases where either by good luck or infinite ingenuity castings had been successfully manufactured whilst still embodying the so-called defect in design. Again, as is pointed out in Mr. André's Paper, on many points there is no unanimity of opinion amongst the foundries as to what is a defective design. Despite everything, the existence of a specification would create interest in foundry technique amongst those whose co-operation has been so insistently sought for so many years. If any such attempt be made, the foundry side must be extremely tolerant, as the postulation of too many hard and fast rules would tend to jeopardise the future of the foundry, by making alternative methods of construction such as welding, for example, appear an easier proposition. It is to be noted that the French brochure, previously referred to, confines its attention to steel castings, and it appears to us that any effort made by the British should initially follow the same precept, as owing to the combination of high temperature and contraction on cooling, added difficulties are introduced for the foundryman. With the passage of time, the designers would automatically utilise the knowledge placed at their disposal when dealing with other types of castings. At the very least their interest would be aroused. Whilst what may be termed "over-specification" might induce the designer to try alternative methods and materials of construction, a well-balanced one would surely result in easier foundry methods associated with higher grade productions at a relatively lower cost price. This would tend to popularise castings and increase output. The suggestion of a specification of design is still somewhat novel, but it certainly merits the serious consideration of the foundry industry. As we have previously pointed out in this column, the foundry owner starts any legal action having the remotest connection with design with a distinct disadvantage, for apparently the law not merely ignores the question, but presumes the foundry is responsible for any inappropriateness discovered in subsequent usage. From this angle alone, any true co-operation which can be had, initially, with the designer tends to eliminate later legal action as to the serviceability of castings. The importance of satisfactory design becomes also of increasing importance when, as so often is the case nowadays, hundreds and thousands of castings have to be made from one pattern. Generally speaking, in such cases the fullest co-operation is already being effected, but, where absent, the effect is to add very materially to the scrap pile.

The main utility of a specification such as Mr. André envisages is that it would be indicative and would raise the general level of design, without being insistent on the meticulous following-out of any set of rules. We on this side of the channel will follow with a good deal of interest any progress the proposition makes in France.

Institute of British Foundrymen

FUTURE BRANCH ACTIVITIES

In reply to letters sent to the honorary secretaries of the Branches and Sections of the Institute of British Foundrymen, asking for information as to the proposed activities during the winter, we have received the following information.

Birmingham, Coventry and West Midlands Branch

Mr. A. A. Timmins informs us that a full programme of Papers has been arranged. Mr. Tipper is to give a Presidential Address, which will be followed by a discussion on Mr. Sheehan's Congress Paper on "Core-Shop Control." Later in the session, Papers from Mr. A. J. Shore, Mr. H. G. Hall, Mr. J. Hird, Mr. W. Y. Buchanan and Mr. L. W. Bolton are promised. The subjects to be covered are respectively "Foundry Management," "Malleable Cast Iron," "Electric Motor Castings in Green Sand," "Sand Testing at Room and Elevated Temperatures" and "Some Experiences with Cupolas."

Bristol Section

Mr. A. Hares states that difficulties in finding a meeting room, coupled with the long distances which members have to travel, precludes the holding of meetings for the time being.

East Anglian Section

Mr. J. L. Francis has sent out a circular letter to all members pointing out that the great majority, something like two-thirds, do not reside in Ipswich, and this, associated with travelling difficulties, has indicated that the holding of meetings would not be satisfactory, but he is asking for comments.

Falkirk Section

Mr. Thomas R. Goodwin has informed us that the Annual Smoker has been postponed, but every endeavour will be made towards carrying out the syllabus as originally planned.

Lancashire Branch

Mr. A. Boyes writes that the session is to open on October 7 at 3 p.m. (instead of the normal 4 p.m.) at the Engineers' Club, Manchester, when Mr. S. E. Dawson is to read a Paper on "Melting Practice." Arrangements for the Annual Dinner to take place on February 3 are continuing.

London Branch

Mr. Barrington Hooper, C.B.E., the Branch-President, tells us that Mr. Daglish, the honorary secretary, has been called to the Colours. Mr. Hooper is calling a Council Meeting in the near future to decide upon future activities.

Middlesbrough Branch

Mr. G. P. Kirk's letter indicates that there is every intention of carrying out the advertised programme except for works' visits and large-scale social events.

Newcastle Branch

Mr. C. Lashly points to the difficulties which exist locally. However, there are to be some informal meetings when circumstances permit. "In the meantime," he writes, "some members of the Council have suggested that as many Papers as possible may be published in your excellent paper and an invitation issued to all subscribers to comment upon the Papers; in other words, to deliver lectures through the medium of the FOUNDRY TRADE JOURNAL and to hold discussions by correspondence."

Sheffield Branch

Mr. T. R. Walker, M.A., tells of a decision of the Council not to hold meetings before January, and adds: "In the meantime we are inviting those who promised to give Papers to complete them so that they may be published in the FOUNDRY TRADE JOURNAL."

Scottish Branch

Mr. John Bell says that a Council meeting is to be held in the near future, but that the opinion of many prominent officials is that the programme should be carried through.

Wales and Monmouth Branch

Mr. J. J. McClelland has sent us the programme for the forthcoming session. The opening social evening has been cancelled, but every effort will be made to carry through the rest of the programme. The authors scheduled to give Papers are Mr. F. J. Cook, Mr. E. Longden, Mr. A. A. Timmins, Mr. F. Dunleavy, Mr. C. A. Howe and Mr. E. J. Kelly.

West Riding of Yorkshire Branch

Mr. S. W. Wise writes that the Council has every intention of carrying through its winter session. An excellent syllabus has been arranged, which includes a Presidential Address from Mr. S. Carter; Papers on "The Practical Application of Monolithic Linings," by Mr. F. Ollershaw; "Mould and Core Drying," by Mr. J. Timbrell; "Essential Details of Modern Foundry Control," by Mr. H. Forrest; and "Further Notes on Moulding Sands," by Mr. S. Carter and Mr. A. W. Walker.

War Risks Insurance

IRON AND STEEL GOODS EXCLUDED FROM SCHEME

In the announcement dated September 12, the Board of Trade indicated their intention of excluding certain products from the scope of the insurance scheme. In a further announcement it was stated that a number of applications had been made to the Board of Trade by responsible bodies requesting the exemption of certain goods from the scope of the scheme on the ground of indestructibility or unsaleability.

The Board of Trade last Friday made an order (the War Risks Insurance (General Exceptions) Order, 1939) directing that goods of the descriptions specified below shall be deemed not to be insurable for the purposes of Part II of the Act. A number of representations made on similar grounds are still under consideration, and decisions will be announced as soon as possible.

The Board of Trade are prepared to consider any further representations which may reach them from responsible bodies in favour of the exclusion of other commodities on one or other of the grounds above referred to.

Amongst the list of goods excluded from insurance by the Order are the following:—Coal and coke and manufactured fuel of which coal or coke is the chief constituent; iron ore; manganese ore of all descriptions, except manganese ores used in the manufacture of chemicals, electric batteries, manganese metal, glass or ceramics; iron and steel scrap; non-metalliferous mining and quarry products, unmanufactured; bricks and tiles of brick-earth and clay, and refractory bricks, blocks and tiles; cinder, scale and slag; pig-iron; ferro-alloys other than in powder form; castings, blocks for forgings, blocks for pressings, forgings and stampings (except where wholly or partly machined) and pressings; pipes and hot-finished tubes; and structural work, including bridge, pier, tank and plate work whilst at producers' works.

Random Shots

Everybody's thoughts and activities at the present time are preoccupied with the situation in which Great Britain now finds herself. Notwithstanding, many people who are old enough find time to remember some of the tight corners, unexpected situations and experiences, gruelling or even occasionally humorous, in which they found themselves during the last war. A friend the other day recalled at least one amusing incident that befell him at that time. At the outbreak of war he was at school in Germany as a boy of fourteen or so. He got back to England after many adventures but without any of his belongings, all of which he had been obliged to leave at the school. Five years later, well after the end of hostilities, his trunk was sent home to him. By this time, of course, he had grown from a somewhat small, thin boy into a six-footer. The fun, he says, that he and his family got out of trying on those school clothes belonging to a forgotten phase in his physical development well repaid them for the loss that he sustained in never being able to wear them out! * * *

Mr. J. H. Kayser, chief metallurgist of the Gillette Industries, also recalls an incident, not of the last war, but of a visit to the Berlin factory about a year ago, but which is worth recording at a time when everyone wishes to feel that our supremacy in the manufacturing world is as sure as our supremacy at sea. He was asked to give an opinion on a press which had shattered, and was shown a fracture of the broken metal. "What's this?" he demanded, on being handed a piece of spongy greyish stuff. "That," replied Herr Direktor, "is the special cast iron we have in use now." "I'm glad you've told me," replied Mr. Kayser. "It looks like coke." * * *

The Nazis, too, are apparently remembering little incidents which have taken place within the last year or so, either real or imaginary, and are using them as propaganda for their own case. Listening-in to a programme of music from Germany a week or two ago, it was surprising, to say the least of it, to hear the music suddenly interrupted by a sepulchral voice which said: "Hello, Mr. Chamberlain. Listen, Mr. Chamberlain, who is going about as an Angel of Peace. At the beginning of this year, Mr. Arthur P. Young, the 'General Direktor' of British Thomson-Houston, was in America, and in an interview with the 'Queen Mary' said that the chances were 80 out of 100 that war would break out within six months. How did he know it, Mr. Chamberlain? Because he was a big armament dealer and you had told him to be ready for war in six months, and also because you had informed him when you were going to start." If Herr Hitler thinks that the idea that all the titbits of conversation with Germans during the last year or two have been faithfully (!!?) recorded in secret Nazi pocket books for future mud-slinging purposes is going to cause any sleepless nights amongst the prominent business men of this country, he is vastly mistaken. The only German monstrosity guaranteed to keep an Englishman awake is the great fat eiderdown affair he is obliged to sleep under in that country!

* * *

To finish this dismal tale of war, here is a refreshing story of how the news of the outbreak of war was conveyed to and received by a certain small boy. He had been very ill and his parents had not taken any war news into the sick room until he was convalescing. At last his father said to him: "You know that we've decided to go and give Mr. Hitler a good hiding?"

"What?" cried his son, wide-eyed, "take down his trousers and give him the cane?"

"MARKSMAN."

Co-operation between Designer and Foundryman*

By M. ANDRÉ

The necessity for strict co-operation between the drawing office and the foundry has long been recognised, and this co-operation should embrace all problems which react upon the making of the castings, such as the choice of material, inspection, shape of the castings, pattern-making and machining.

In what follows, shape will be dealt with, for it occupies the outstanding place in any system of co-operation. Already in 1925 the Research Association set up in Great Britain to study the actual making of castings published a Report in which the importance of design was stressed in the following terms: "In the present stage of the development of steel castings, it is no exaggeration to say that the first essential towards progress is the design of the castings."

Ever since the making of increasingly complex castings has been developing, yet collaboration between the designer and the foundryman still remains, in the majority of cases, merely an exchange of views, usually written and seldom oral, and it must be recognised that this method does not produce the best results, for the outcome is usually loss of time, endless discussion and sometimes bad feeling. Quite often a casting is a component of a machine assembly, and its modification has to be considered in conjunction with other components in course of manufacture.

Even allowing that the assembly uses only castings, it is seldom that the foundry receives the designs of all the castings simultaneously, and it is consequently annoying to ask for modifications without knowing the repercussions on the other castings. To obviate these annoyances, the late Mr. Ronceray in his lectures to the Paris Foundry School advanced the idea, several years ago, of choosing a highly qualified referee to whom designs could be submitted.

At the 1937 French foundry conference, Hénon advocated the notion of attaching a foundry technician to the drawing office. Such an organisation would be extremely desirable, but its realisation carries with it great difficulties, if only because of the fact that its functioning depends solely upon the engineers, who do not always appreciate its necessity, for quite often, as Hénon has said, the foundryman gets excited and the engineer finally insists on the original design.

An attempt was made in France in 1936 to effect this co-operation from a quite different angle. The initiative came from the engineers since this attempt was carried out under the auspices of the shipbuilders' employers federation. Its findings were embodied in a small brochure entitled "Guide à l'Usage des Dessinateurs de Pièces d'Acier Moulé" (Guide for Designers of Steel Castings). The editing was entrusted to a committee comprising both engineers and foundrymen presided over by the late Mr. Ronceray.

The object sought by the authors of this brochure was defined as follows:—"The study herewith presented will provide shipyard designers, who have not had practical foundry experience, with the means of avoiding the principal errors of outline when designing steel castings to be put out to public tender. It will thus help in the direction of the co-ordination of efforts of the shipbuilder and the founder for the production of castings of current importance—a problem both delicate and recurrent."

It does, moreover, form a sort of a specification for the design of steel castings. Is such a specification possible? Can one point to results? These are the two points which it is proposed to examine in roughly describing the scheme of what could be a specification of designs, based on the broad outline given by the "Guide des Dessinateurs" referred to above, which is now to be found in most marine engineers' drawing offices.

Basic Rules for Designing Steel Castings

The brochure referred to, having as its object the familiarising of designers with the work of the foundryman, was—because of this fact—divided into several sections, each one dealing with the elimination of a specific defect.

The author, in what follows, has adopted a different grouping of the rules given by using headings which better correspond with different articles that could form a specification for the design of castings.

I—General Conception of Castings

(*a*) Castings should embody, as far as possible, thickness variations which are regular and continuous from one extremity to the other; this done, the greatest thickness determines the height of the mould.

(*b*) When this consummation is not possible, the thick sections should be localised so as to permit feeding without the addition of a large number of heads. The latter constitute in such cases salients preventing the contraction of the castings, and their multiplicity involves an increase in the cost of production.

(*c*) The castings should be castable in such a way that the heavy sections can be fed easily by placing all the machined surfaces in the vertical or towards the bottom of the mould. This scheme is the one which operates in the direction of yielding clean surfaces, free from inclusions—an important factor for the machine shop, especially when the surfaces form joints.

(*d*) The external shape of the castings should not, except where absolutely necessary, carry local undercuts, which markedly increase the price by necessitating the making of cores or blocking-out.

(*e*) The number of cores ought to be reduced to a minimum. The cost of patterns will be greatly reduced when the different cores have a simple and constantly recurring shape.

(*f*) It is often advantageous to envisage two castings instead of one, when a part of the casting presents a volume of space clearly less than that of the other part of the casting. The moulding of such a casting would necessitate the use of a box part of much larger size than is fundamentally essential and is an unnecessary waste.

In such a case, for steel castings, the mould separated in two parts and the assembly by welding will in general be less onerous, but the initiative for such a solution rests with the designer, who alone has full knowledge of the working conditions.

(*g*) The presence of widely separated bosses increases the cost of the castings. It is often the cause of machining troubles consequent upon the displacement of bosses due to variations in contraction. These bosses would be advantageously placed in position later by welding or mechanically, which allows of their exact positioning.

(*h*) Welding is equally satisfactory for attaching ribs when the chance of a non-run-up rules out the making of a core box or allows of the use of a simplified pattern or again eliminates deformation. For example, the moulding of a casting having the form sketched in Fig. 1 and having several ribs connecting the two members will take very much longer than the moulding of a casting without ribs. Moreover, the presence of ribs will bring about the deformation of the other members, involving the necessity of straightening. In spite of everything, thicknesses will be less regular than if the casting is made without ribs.

II—Concerning Design

(*a*) It is desirable that foundry drawings should be based on a suitable scale so as to show the different sections and views on one sheet.

(*b*) It is always desirable when designing castings to show clearly the machining allowances. This rule is indispensable when it refers to thin castings, for castings followed through to the finished state can superficially present a perfect regularity, yet on the other hand show irregularities contrary to good production, on which the machining allowances have been based.

As a general rule, all castings of a thickness less than or equal to 30 mm. (1¼ in.) should be drawn with machining allowances, which will be taken as equal to 10 mm. (0.405 in.), the founder having the right later to modify these allowances.

(*c*) The drawings should show, if at all possible, the importance of the different parts of the castings from the point of view of strength.

(*d*) Moreover, the drawings should also indicate which surfaces must be particularly clean; for example, surfaces destined to form tight joints (cf. I *c*).

III—Design Detail Examined

The final appearance of a casting very often depends on details. These must be examined with extreme care.

A.—As-cast and Machined Dimensions

(1) The "as-cast" dimensional tolerances are generally stipulated by the particular specifications, but it is important that the dimensions after machining do not act adversely against the play of these tolerances. On the casting shown in Fig. 2, it is essential that the side *a* should be such that if the side *l* is within the tolerance limits, the machined portions remain true in respect to the as-cast parts, but the projecting portion could be eliminated in the case where the casting would turn out to be bigger than was expected, everything else being correct from the point of view of tolerances.

If $\leqslant$ is the allowable tolerance on the side *l* and if one estimates that it is essential to have a minimum projection of 5 mm., it is necessary to have

$$a > \frac{\leqslant}{2} + 5$$

(2) The tolerances ought also to be of sufficient size for machining to be carried out despite any admissible deformation of the castings. In the case of Fig. 3, for example, if L be sufficiently large, the casting can present a deflection of three in a thousand with a maximum of 15 mm. It is thus necessary to provide for

$$a > \frac{3L}{1{,}000} \text{ or } a > 15$$

This minimum value of *a* is especially necessary where the castings are thin, because of the increased liability of deformation.

(3) In the case of machining hollow castings, these should be calculated so as to reduce as far as possible thickness variations, but they should nevertheless be sufficient to allow the machining of the casting despite any variation in contraction. Assuming a maximum variation of 12 per 1,000 on the amount of the contraction, a casting will be obtained of which

D

*Translated from a Paper read before the 18th Annual Conference of the French Foundry Technical Association. The author is on the staff of the Homecourt Works of the Forges et Acieries de la Marine et d'Homecourt.

the as-cast diameter will be at least equal to $\frac{D}{1,012}$. For machining to be possible whilst allowing a play of 5 mm., it suffices to have

$$\frac{D}{1,012} = d + 10$$

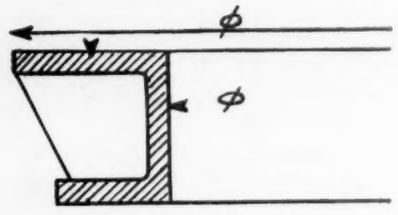


FIG. 1.

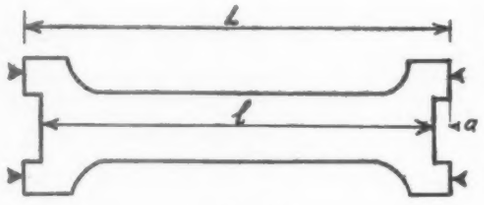


FIG. 2.

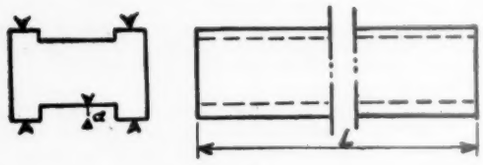


FIG. 3.

FIG. 4.

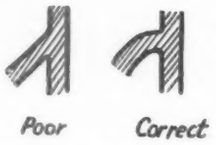


FIG. 5.

FIG. 6.

FIG. 7.

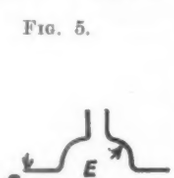


FIG. 8.

A higher value of D is needless and makes the feeding of the casting more difficult when this is cast vertically. Of course, this case can combine with one or the other of the two previous cases, or both together, which can lead to giving to D a higher value than that indicated above.

B.—Joints

(1) It is necessary to point out that all joints involve spreaded machining allowances. As it is practically impossible to feed them all, it is important that the joints should be designed to the requirements of the foundry.

(2) Joints should never be designed as acute angles. The latter should not exist in foundry practice.

(3) Joints should always be designed as right angles; oblique joints introduce acute angles, which favour the creation of draws and blows (Léonard effect), and increase the machining allowance on the metal. (Fig. 5.)

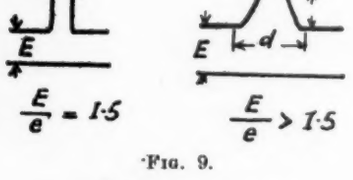


FIG. 9.

$R = \frac{E}{2}$ with minimum of 10 mm.
$h = 2(E - e)$
$d = 2{\cdot}5(E - e)$

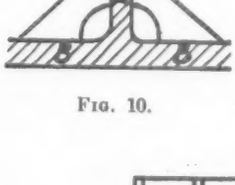


FIG. 10.

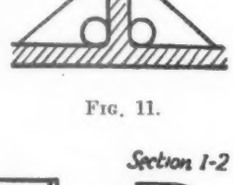
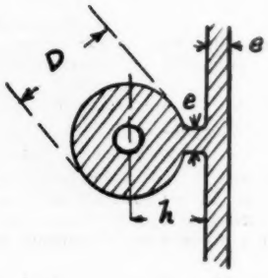


FIG. 11.



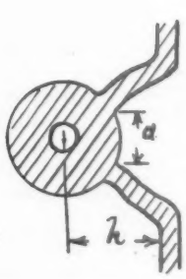


FIG. 13.

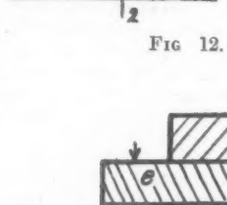


FIG. 12.

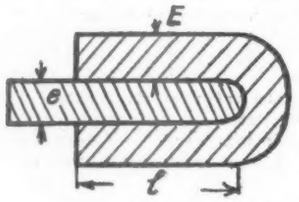


FIG. 14.

(4) A joint should never be associated with a change in thickness. By so doing two possible faults are introduced. (Fig. 6.)

(5) Avoid joints carrying four arms or ribs. Two of them should have a minimum distance between equal to twice the thickness of the member. An insufficient spacing is still more harmful than the absence of spacing. (Fig. 7.)

(6) In the case where four arms or members are indispensable, make the roots very large and provide chills or webs. (Fig. 8.) The use of chills is called for if $E > 2.4e$, which may be the width of the junction. Use webs if $E > 3e$ with a web of diameter e. This web is possible only if the height of the junction is not greater than four times its diameter.

(7) For two member joints the roots should have the values shown in Fig. 9.

(8) In the case of the joints shown in Fig. 10, it is necessary to provide webbing but it is essential that the points A and B are placed beyond the source of the roots (see Clause 7). Webs such as are shown in Fig. 11 should never be used for they allow acute angles to persist.

(9) If the strength of the casting allows it, it is equally of service to provide webbing all along the joint of one member on another, as shown in Fig. 12.

C.—Isolated Bosses

Bosses as designed on castings often, like machining allowances, make for difficulties in feeding.

(1) If it is essential that bosses be incorporated in the casting (see Section I, Clause *g*), the foundryman must ensure their solidification before the neighbouring members by chilling. If the bosses have to be drilled later, it is essential that the blueprint gives the diameter of the hole, in order that a chill can be placed there, which will be taken out on machining.

(2) The external diameter of the bosses should be designed larger than necessary so that any variation of contraction will nevertheless leave sufficient thickness of metal as is shown on the design.

(3) It is necessary to avoid bosses connected to the casting by a thin member (Fig. 13, left) and forming re-entrant angles which favour the inclusion of blowholes. The distance h is a function of the relative thicknesses of the boss and the adjoining member.

$$\text{Thus } h > \frac{3D}{2}$$

Where the distance h is essentially less than this value, it is usually possible to adopt the method shown in Fig. 13 (right) by making

$$a = \frac{D}{2}$$

D.—Cores

(1) All cores must be extractable unless there is an explicit note to the contrary on the blueprint.

(2) Cores should, as far as possible, be capable of assembly without irons, the removal of which in certain specifications is extremely difficult. The core prints should be generous in order to assure the solid support of these cores and allow of the fettling of the casting.

(3) If the ultimate use of the casting—water tightness, for example—imposes a limit on the number of prints, these should be placed towards the top of the mould to resist the pressure which tends to lift cores. The total pressure is equal to the pressure of the metal plus the ferrostatic pressure, which for certain castings can attain considerable proportions.

(4) It often happens that castings are hollowed out as shown in Fig. 14. To assure the soundness of the casting, it is desirable that

$$e \geqslant E$$
$$l \leqslant 3e$$

Possibility and Potentialities of a Specification of Designs

A sketch has been drawn above of what could be incorporated in a specification for the design of castings. Is such a specification possible? Amongst the rules postulated certain of them are doubtlessly rather vague and it is possible that even their enunciation presents but little

interest. Yet it is exactly the same thing with all specifications because for all materials certain points cannot be completely defined and they have no other object but that of drawing attention to them.

A specification of designs for castings would not escape from this rule, but it would not be based only upon definable points (such as the examination of details), being those which most frequently introduce queries from the foundrymen. This statement should suffice, on these grounds alone, to call for the specification envisaged.

Since the publication of the brochure issued by the [French] shipbuilders' employers' federation, the author has found himself in a position several times to state that some of the indications given have been followed. Quite recently a design even carried a sketch of junctions which were detailed for members of very different thicknesses.

From this there is a definite indication of the fact that designers are ready to apply the explicit demands of the foundryman, and it would be wrong not to respond to this possibility of co-operation.

Quite probably, it would be extremely interesting if foundrymen would associate themselves in establishing a specification for designs and it seems that the French foundrymen's association may be called upon to act as a clearing house for any attempts that may be made. This is an indispensable condition for the success of any such attempt, as it would imply that the specification was accepted by all foundrymen.

Amongst the rules indicated, certain of them are apparently unacceptable to some foundrymen. For example, the author has not been able to include the idea postulated by Mr. Heuvers that the engineers should design junctions of members carrying thicknesses as widely different as possible, because it is a personal opinion that the troubles resulting from differences in solidification would be greater than the advantages resulting from the decrease of masses at junctions.

The application of these principles will not completely suppress the exchange of direct views between the drawing office and the foundryman, but it will reduce their magnitude, which would be of advantage to the foundryman, who sometimes hesitates to ask for modifications, and also to the designer who takes more notice of them the fewer there are and the less frequently they occur.

Book Review

The Elements of Sheet-Metal Work By W. Cookson and A. Bold. Published by The Technical Press, Limited, 5, Ave Maria Lane, Ludgate Hill, London, E.C.4. Price 6s. net.

This is an ideal textbook for the apprentice sheet metal worker, for it advances the subject by such easy stages that the absorbing of the rules of triangulation becomes a light task. The only assumption is that the student can add, subtract, divide and multiply whole numbers. The book is made up of eleven chapters, the first two of which cover the essential mathematical principles. From there onwards to Chapter VII, the student progressively learns the setting of jobs. Chapter VIII, which deals with metals and their properties, is an essential for the proper understanding of sheet metal working, but it is insufficiently developed and is worthy of considerable extension or at least an indication where additional information is to be found. Chapters IX, X and XI cover practical applications and are excellent. The authors have served a useful purpose by the publication of this book.

Resistance of High-Silicon Malleable Iron to Drilling*

By H. A. SCHWARTZ, R. C. KASPER and N. E. MERTZ

In view of recent interest in malleable irons containing what would a few years ago have been considered abnormally high silicon contents, it seemed desirable to gain laboratory knowledge of the machinability of such irons in relation to silicon and carbon content. For various reasons, the chief of which is that in the Research Laboratory of the National Malleable & Steel Castings Company the measurement of drilling resistance has been frequently carried out, a drilling test was selected as a means of comparing the machinabilities of the several materials.

Experimental Method

The machine and method for making drilling tests have been described elsewhere.† The material available for the investigation consisted of a series of commercial malleable irons having the following compositions before malleablisation:—

	Carbon, per cent.	Silicon, per cent.		Carbon, per cent.	Silicon, per cent.
No. 1	2·09	1·83	No. 10	2·16	1·60
No. 2	2·31	1·39	No. 11	2·14	1·48
No. 3	2·12	1·60	No. 12	2·21	1·67
No. 4	2·33	1·58	No. 13	2·21	1·55
No. 5	2·33	1·58	No. 14	2·24	1·78
No. 6	2·03	1·68	No. 15	2·25	1·68
No. 7	2·20	2·10	No. 16	2·36	1·99
No. 8	2·20	1·60	No. 17	2·16	1·50
No. 9	2·10	1·66			

The specimens were all annealed together using a commercial cycle as follows:—5 hrs. from room temperature to 815 deg. C.; 4 hrs. from 815 to 925 deg. C.; 46 hrs. at 925 deg. C.; 4 hrs. from 925 to 905 deg. C.; 22 hrs. from 905 to 680 deg. C.; and 26 hrs. within the range of 680 to 715 deg. C.

Tests were made generally on four specimens of each kind. The rate of penetration of a standard ½-in. drill pressed against the specimen by a load of 220 lbs. was recorded, and also the torque of a similar drill penetrating the material at the rate of 0.005 in. per revolution. Dulling of the drill was provided against by procedures described in the earlier Paper. The results were as given in Table I.

The multiplicity of results on material No. 17 was obtained in order to evaluate the precision of the test method.

Discussion

By the usual statistical methods the authors find the standard deviation of the results on a single material, No. 17, to be 6.4 revolutions per 1-in. penetration and 2.28 in.-lb. of torque. Assuming that either variable could be represented by an equation of the form

$$\text{Variable} = a + b\,\text{Si} + c\,\text{C},$$

the values of the constants a, b and c were calculated by the usual method of least squares. In this way, it is determined that

Revolutions per 1-in. penetration =

$$257 - 0.49\,\text{Si} - 0.80\,\text{C}$$

and

$$\text{Torque} = 38.0 - 0.338\,\text{Si} - 0.154\,\text{C}.$$

TABLE I.

	Revolutions per 1-in. penetration.	Torque, in-lb.		Revolutions per 1-in. penetration.	Torque in-lb.
No. 1	240	35·7	No. 11	260	34·8
	240	38·8		270	37·6
	240	34·8		290	39·4
	230	38·2		290	38·2
No. 2	260	36·0	No. 12	290	39·4
	260	37·6		300	34·8
	250	37·6		280	38·8
	250	37·0		280	37·6
No. 3	240	37·3	No. 13	270	39·4
	240	36·7		240	39·4
	240	38·8		270	35·1
	235	36·3		270	35·1
No. 4	240	41·3	No. 14	250	30·2
	280	35·4		260	30·2
	280	37·6		360	35·1
	280	38·8		250	36·3
No. 5	270	37·6	No. 15	270	38·8
	270	38·5		240	36·3
No. 6	240	36·3		260	35·4
	240	37·6		260	40·0
	240	37·0	No. 16	260	35·1
	230	38·8		260	37·0
No. 7	260	37·0		260	37·3
	240	37·6		240	38·2
	240		No. 17	240	32·6
	240			240	33·9
	240			240	30·2
	240			240	35·1
No. 8	220	33·3		240	34·2
	220	44·0		240	34·8
	240	33·0		250	35·1
	260	36·0		240	35·1
No. 9	240	35·7		230	31·4
	240	36·3		240	36·7
	230	41·6		230	37·0
	230	37·0		250	38·8
No. 10	260	38·2		220	
	260	37·9			
	250	33·3			
	240	38·5			

In these equations Si and C are the silicon and carbon contents expressed in per cent.

Computing the deviations of the observed values from the calculated, a standard deviation from the calculated value of 18 revolutions per 1-in. penetration and of 2.31 in.-lb. is found.

It is to be noted that the agreement between torque data and the calculated value is about as close as the expected accuracy between frequently-repeated runs of the test, whereas the scatter of the penetration data is about three times as great above and below the calculated value as the scatter of observations on a single material above and below the average.

It is probably a reasonable conclusion that unconsidered variables affect the penetration test by detectable amounts, but not the torque test.

Conclusions

It is concluded that both carbon and silicon improve the machinability of malleable iron as measured by the rate of penetration of a standard drill or as measured by the torque on a drill running with a predetermined advance per revolution.

Silicon is about twice as effective as carbon in reducing the torque, and carbon is almost as effective as silicon in reducing the number of revolutions required to penetrate 1 in. at standard load. The results with regard to torque are less affected by unknown variables existing between different heats than the results regarding penetration.

*Paper presented to the Annual Meeting of the American Society of Testing Materials. The work was carried out at the Research Laboratory of the National Malleable and Steel Castings Company.

†H. A. Schwartz, "Factors Affecting Machinability of Malleable Cast Iron," Transactions, A.F.A., Vol. XXXVIII, p. 210 (1930).

Notes on Steel Foundry Practice

By S. LEETCH

(*Concluded from page* 198.)

Dry Sand of Stronger Mix

The production methods employed in the moulding of the runner disc shown in Fig. 21 form a striking contrast to those discussed in the moulding of the traction yoke, and are a good example of the moulder's craftsmanship. The mould, with some cores set, is shown in Fig. 22. No pattern was supplied, and top and bottom striking boards, or sweep boards, were used for making the top and bottom moulds, attached to the spindle in the usual manner. The importance of rigidity of the spindle in the vertical and the necessity for gauge sticks to prove the mould's accuracy in a green state cannot be too strongly stressed. The joint face is set out in eleven equal segments radiating from centre, and green-sand split pieces were used in the centre boss of the bottom for contraction purposes. There is a danger of pulling at the juncture of top plate and vanes, and also at the juncture of lower skirting ring and vanes. There is a difficulty in choosing suitable chills, for the chilling is effected by bedding in nails along the joint edges of cores. The secret of satisfactorily closing this job is that one core has to be split, and the front portion fixed in position, before any full vane cores are used.

FIG. 21.—RUNNER-DISC CASTING.

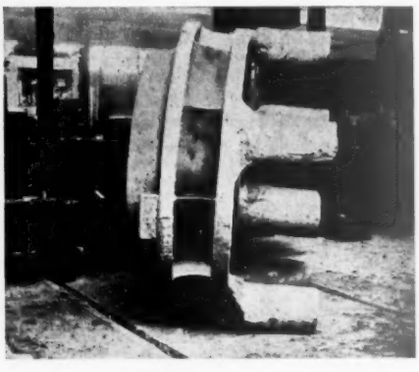


FIG. 24.—SHOT-BLASTED RUNNER-DISC CASTING.

Split Core and Corebox

Fig. 23 shows the joint of the core previously referred to, also the vane corebox, from which all the vane cores are made. It is essential to ensure that all screws are tight and all loose pieces in position. Spiral core irons and lifting staples are cut off to proper length. The method used is to take out the back block, the front of which forms one face of a vane, and ram about one inch of sand in the bottom; then the core irons are placed in position, and connected to lifting staples. Next, sand is rammed about 1½ in. thick up the sides of the box, leaving a space centrally in the core for ashes. The loose piece which was removed to allow the undercut portion to be rammed is now replaced, care being taken to ensure it is bedded down in its correct position. When this has been ascertained it is screwed tightly in position, then the moulder continues to ram to the top of the corebox and to some distance past where the joint occurs. This will ensure firm sand for the cutting of the joint. The joint is made as is shown. After inserting ½ in. tubing in the bottom portion of the part-core already made, a rod is pushed down this piece of tubing, then another piece of tubing is slid over the exposed length of rod. The bottom face of this tubing rests on the top face of the first piece which is bedded in the part-core already made. This second piece of tubing will be rammed up in the second part of the core. In order to ensure a clean breakaway of the joint faces, carefully lay pieces of damped brown paper along the joint for parting purposes after drying, taking care there are no crinkles or overlapping of the paper; then ram up the second portion of the core. Use care when strickling the top face of the core as this forms the underside of the top plate. As will be seen from the side view of the corebox the top face is stepped down towards the centre. A frame is placed on this portion, the loose piece, previously referred to, is removed, and the damped paper is placed in position. Parting sand is spread on the back face of the core, and the space behind rammed up with soft bedding sand; the stepped portion on the top already referred to is filled with similar sand. A flat core plate is placed on the flat face thus formed, the whole clamped together and turned over, the box being then removed from the core. The cores must not be allowed to sag or swell, and it is only by drying in this vertical position, supported by rammed backing sand that true shaped cores can be obtained. When dry, draw out the rod and separate the two portions of the core. On the full cores, the air vents go through the back print and also into the centre print of the bottom part of the mould. Of course, in the jointed core, the air vents of the front portion are taken into the centre print of the bottom part of the mould, and those of the back portion through the back print.

FIG. 22.—MOULD FOR RUNNER DISC AND PART OF THE CORES IN POSITION.

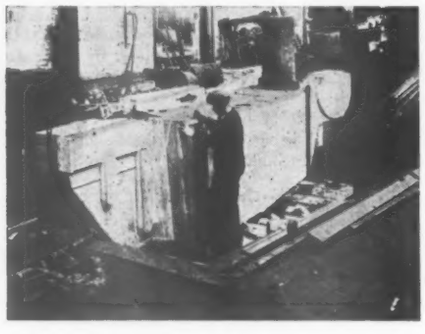


FIG. 25.—SHEARING PRESS ARM PATTERN IN MOULDING BOX.

Fig. 24 shows the shot-blasted casting with some smaller heads removed in order to give a better view of the blades or vanes. The vanes were so clean after shot-blasting that instructions were given to the fettlers that no hammer marks or chipping was to take place, as any blemishes would be removed by hand grinding.

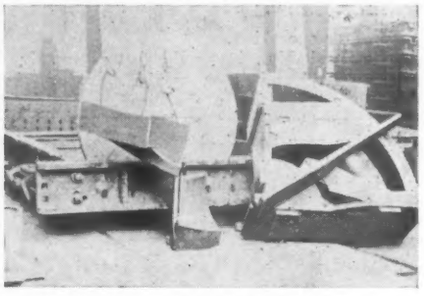


FIG. 23.—VANE CORE BOX.

Sand.—The mould was made of a dry-sand mix, stronger than the one previously detailed. It consisted of two parts of Belgian red and one part of Chelford silica, together with 6 to 7 per cent. moisture. This mix is intermediate between reclaimed dry sand referred to in the last example and compo. Many steel founders have one mix for dry sand work, and when this is not considered to be sufficiently refractory, compo is used. The cost of compo is more than twice that of the Belgian silica mix, and in many instances the face of the casting is not so good. The vane cores were made of the standard oil-sand mix referred to previously. The mould and cores were painted with a silica paint whilst hot, then drawn back into the stove to dry the paint thoroughly. The silica paint has the following constitution: 10 parts of silica flour; 4 parts of core binder, and 6 parts of water. It is mixed in the same plant as the core binder previously referred to. It is issued

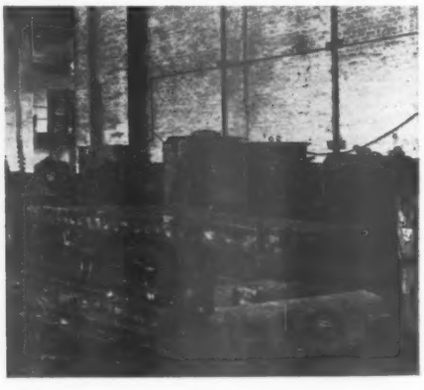


FIG. 26.—DRYING ARRANGEMENTS FOR BOTTOM PART OF MOULD.

to the men in cans, which have a stirrer fitted to ensure no settling taking place, and no alteration in quantities is permitted.

Compo and Shearing Press Arm

Fig. 25 shows the pattern of a large shearing press arm, the weight with feeding heads being 32 tons, whilst overall dimensions are 15 ft. 6 in. by 5 ft. 6 in. wide and 6 ft. 6 in. deep. In making a casting of this type and size, the chief problems are not the running, feeding or question of pulling. There are a number of suitable places for the in-runners to be fixed, the

Fig. 27.—Closing Operations for the Press Arm Mould.

design lends itself for placing sufficient number and size of feeding heads to ensure soundness, and the minimum wall thickness is usually such as practically to eliminate the dangers of pulling. It is usually very clear where brackets to prevent pulling should be placed. Where the chief dangers lie are from the pressure exerted by the escaping gases, from strain produced by the weight of the molten steel and gases, cores moving, and lack of free passage for the air from the internal cores. Before commencing work it is essential that the pattern and coreboxes along with the drawing should be carefully studied and the complete production plan of heading, running, venting, etc., be decided upon. There is an awkward coring proposition for the core, which is made in four parts. The illustration shows the pattern in position, ready to commence moulding after the preliminary work has been done, but as this preliminary work is so important, it will be of interest to describe it briefly. A permanent pit, 20 ft. long by 14 ft. wide by 5 ft. deep, with a proved solid foundation and brick walled sides, is cleared. Rails are set at intervals of 2 ft. and sand is firmly rammed between the rails. Flat bottom plates, 2½ in. thick, with spaces between for venting purposes, are firmly secured to the rails in order to eliminate the danger of springing. A drag part, 20 ft. by 9 ft. by 18 in. deep, is set in the pit. The pattern is placed in position on loose brick supports (which are removed as the ramming proceeds), the height of the supports being such as to bring the joint face of the mould level with the top face of the last drag part. The bottom layer is formed by bricks placed on edge with 1 in. space between; into the spaces fine ashes are rammed and vents arranged; a

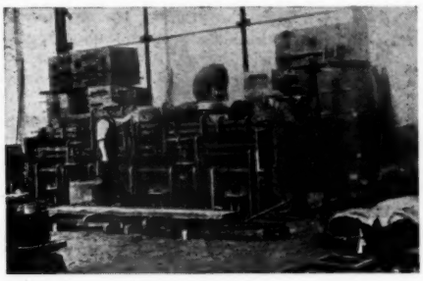


Fig. 28.—Mould for Press Arm ready for Casting.

3-in. layer of sand is then rammed, followed by another layer of bricks and ashes, and then a 4-in. layer of compo is rammed up to the bottom face of the pattern. Ramming of the sides and ends then takes place, the 4-in. thickness of compo being backed with bricks and ashes, followed by re-conditioned backing sand, and as the ramming continues, other drag parts are placed in position, securely fastened to the lower drag part.

Vertical steel reinforcing bars are rammed up behind the compo, 9 in. apart, and fastened back by bars and bolts to the sides of the box. These bars are the depth of the bottom part, and where, due to the shape of the job, there are large areas of space between the pattern and the box sides, ingot moulds or similar heavy blocks are rammed in—these save ramming and drying time and act as good reinforcement to the mould. The joint is made along the top edge of the pattern, and after the joint face has been made, the runners arranged, etc., the heads and top part are placed in position and rammed. The top part is removed, finished and taken to the drying stove; the pattern is stripped, runners removed, the bottom part of the mould finished and prepared for drying on site, it being too heavy to lift.

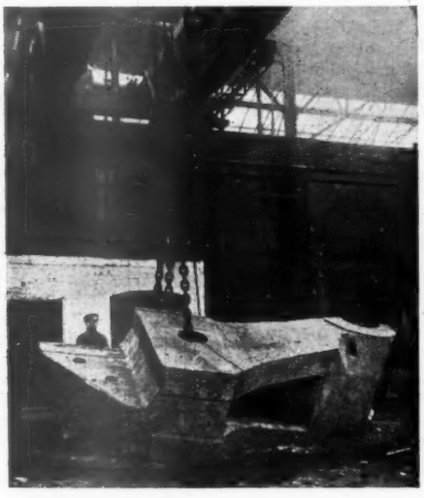


Fig. 29.—Finished Press Arm Casting with Feeding Heads Removed.

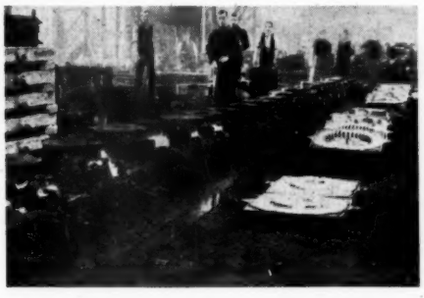


Fig. 30.—Apprenticeship Bay.

Drying Arrangements for Bottom Part

Fig. 26 shows the two heating units in position. It will be noted that the two layers of old bricks and slurry mortar make a fairly level face, and a covering of 2 in. thick plates completely boxes in the mould. Immediately under each box is the flue hole, down which the hot air is induced. It is of interest that the two drying units shown are operated differently; that on the left—a Polford—is electrically operated by means of a 1 h.p. motor driving a fan at 1,400 r.p.m., and the one on the right is fed by compressed air at 80 lbs. per sq. in. direct from the service pipe. Both work on the induction principle, *i.e.*, a jet of air is forced under pressure direct down the flue into the mould, causing the heat from the coke fires to follow in that direction. The coke skips placed handy for stoking are noteworthy. The mould was dried slowly, taking three weeks, the heat being maintained throughout, and it was decided to take a comparative cost. This test showed the compressed air unit to be 45 per cent. higher to operate than the electric unit, but it must be stated the former was a home-made unit of ripe age. However, there is no doubt the electric heater is more economical, as it is a self-contained unit and can be plugged in to the existing wiring, whereas the compressed air unit necessitates the running of the expensive compressor plant, even when it is not needed for other purposes.

The closing operations are shown in progress in Fig. 27, with the third section of the core previously referred to being fixed in position. The core irons were so made that all four sections could be bolted together, then the whole bolted back through the print on the taper bottom; bolts were also taken through the top print and the air vents connected up and taken off through the top and bottom core-prints.

The mould is shown ready for casting in Fig. 28. The object in the centre on top of the mould which has the appearance of a pipe bend is of particular interest. It has always been realised that there were advantages to be gained from pouring the steel into a warm mould, and this heater is an adaptation of the type used for drying ladies' hair. This system keeps hot air inside and prevents dust, etc., entering moulds. Two ladles were used for pouring, one carrying 17 tons and the other one 11 tons. The larger ladle started pouring and after 10 tons had been poured the second one came into operation, the runners, of course, having been previously placed to suit. This method meant less strain on particular cores than if run from one end only. The metal from the two ladles brought the steel well into the heads, then a further ladle with 4 tons of steel took up position, and this hot steel was poured into one of the largest heads, thus ensuring hot steel for feeding purposes.

Fig. 29 shows the finished casting with feeding heads removed. With a casting of this size and weight the risks are not finished with when pouring has taken place satisfactorily. In fact until the casting has been thoroughly annealed and the strains taken out there is always the danger of "clinking" or cracking, and when this occurs it invariably means scrapping the casting, for it is a very different thing from a contraction pull which will not extend, and which can usually be satisfactorily welded; therefore, the casting must be knocked out whilst at a heat which will allow one to bear the hand on its lightest section, for a very short period only, *i.e.*, just touch it and withdraw hand, and kept at this heat by means of fires until the heads have been burnt off, and it is safely in the annealing stove. It must not be allowed to stand in an exposed or draughty place whilst burning off the heads. If there be any risk of it cooling during burning off the heads it must be annealed with heads in position.

Compo

Compo is the most expensive refractory material used in moulding, and it is safe to say that every steelfounder and every supplier of refractory materials has his own particular mix. The fact is the "composition," to give it its full title, is the result of adding this, that and the other, until a mix has been obtained which has given satisfactory results. The mix has been jealously guarded and very few people have known the ingredients, and fewer still have dared to alter them for fear that the result will be inferior. However, the introduction of chamotte, which is a highly-calcined clay, has formed a basis upon which to build, and most steelfounders are now engaged in building up known quantities for certain thicknesses and weights of castings, and in the near future chamotte mixes will replace the old compo mixes, but, of course, until uniform results are obtained, each founder will continue to use the mix he knows will give satisfactory results.

This mould was made from the following compo mix: 2 cwts. calcined silica rock; 3½ cwts. used firebricks; 3 cwts. Chelford silica sand; 90 lbs. ground fireclay; 1½ galls. sulphite lye; and 12 lbs. carbon (old electrode).

The silica rock and firebricks are crushed to ¾-in. cube size in a K.B. pulveriser, then ground in a very heavy two-roller mill to ¼-in. cube downwards, the other ingredients are then added, the total grinding taking 2½ to 3 hours. A matter of 3½ gallons of water are sprinkled as emptied from the mill—then the mix is passed through a Royer mixer. This last operation has been found most beneficial.

The circular cores were made from the following chamotte mix: 1½ cwts. chamotte, 5 cwts. used firebricks; 1½ cwts. ground fireclay; and 15 lbs. sulphite lye. It was milled for 2 hours, water added to suit, and the mix afterwards passed through the Royer machine.

The mould was painted, before drying, with the following paint: 11 lbs. ground plumbago; 38 lbs. silica flour; 1 lb. bentonite (to keep mix in suspension); and 4½ lbs. core compound, water being added to suit. The cores were painted with the same mix before drying, pulled out of the stove, again painted when hot, and returned to stove for paint to dry.

Apprentices

The majority of the lads enter the foundry at 14, either as office lads or lifter bench lads, and before they are 16, those who are selected to serve their time are actually moulding. The remainder are given the opportunity of going elsewhere before it is too late for them to learn a trade. None is allowed to work on moulding machines, each lad making his own mould and closing it; all have experience in core-making; by stages they graduate through the various types of moulding, and when nearing the end of their apprenticeship, they work with experienced men. They are encouraged to attend evening classes, but it is found that not many avail themselves of this opportunity, so the firm has its own methods of teaching them how to read a drawing, etc. Their progress is recorded on cards, and they are given awards for successes, but no matter how convincing a scheme of training appears on paper, it is very strongly felt that, backed by long experience, the most important factor is the selection of the foremen for this work, on whom depends far more than making good craftsmen. The author has had the happy experience during this last twenty years of working with foremen who have always had the lads' interests at heart, and they have placed their interests first, and, by their advice and daily personal example, they have guided the moulding of characters along with that of craftsmanship. In conclusion the author desires to thank the Directors of Edgar Allen & Company, Limited, for their permission to publish this Paper, and his colleagues, Mr. Swanwick, Mr. Gardner and Mr. Jow, for their help.

The Renaissance of the Steel Casting and the Rôle of the Metallurgist

In his reply to the discussion on his Paper* which was presented to the International Foundry Congress in London in June, MR. FREDERICK A. MELMOTH, the author, writes:—

The engine bed, side frame and underframe castings mentioned by Mr. T. Henry Turner have been made for a considerable time in the U.S.A., quite successfully, and illustrations of them have been included in many articles published in the technical Press. It is true that careful records kept by the manufacturers of such castings substantiate claims that integral casting of such members results in considerable economy of maintenance and longer life. It is equally true, however, that the phase has existed when steel castings were being replaced by other materials, often without rhyme or reason, or on unsubstantiated claims of economy or increased efficiency.

During the past few years, in spite of the very slack state of industry generally in the United States, the value of the steel casting is becoming more and more to be realised, and its scope of application widened appreciably; hence, the choice of title for the Paper. It is believed that a return to normal productive conditions will find the steel-casting industry of the United States in a much stronger position, both technically and economically, as a result of the generally improved methods of manufacture and control which have developed during recent years.

The author is in complete agreement with Mr. Turner regarding the supply of trained metallurgists for the advancement of steel-foundry work, as at no time in his experience has there been such a considerable interest shown by metallurgists in steel-casting production, which interest has been evinced by a desire to become associated with the industry.

When Alloy Additions are Needed

Replying to Mr. J. Deschamps, the author has stated in several Papers that a resort to alloy additions was unnecessary until the potentialities of plain carbon steels were fully utilised. The matter of design and size of casting exerts a controlling influence on the type of heat-treatment to which it can be subjected with safety, and recourse is made to alloy additions frequently only for this reason, that it permits the application of a less stringent form of treatment to produce similar physical characteristics.

In spite of this, the author has regretfully to concede that if Mr. Deschamps can produce intricate steel castings of, say, around 1½ to 2 tons each in weight, with test-bars cast integrally on the castings, and use a plain carbon steel to produce physical test results with regularity equal to those mentioned in the instance he quotes from the Paper, he is well ahead of most exponents of the steel casting. For his own information, the author would welcome the opinions of other producing members of the industry on this matter, as it is of considerable importance in controlling one's opinion as to the stringency or otherwise of existing specifications. Unfortunately, it has to be remembered that specification figures represent minima, which means that, to ensure safety, the potentialities of the material should be considerably higher than the demanded figures.

U.S. Specifications

Replying specifically to Mr. Deschamps' question regarding specifications, it is not felt in the United States that, generally speaking, specifications are too lenient. The author's experience, as a matter of fact, is that they are rather more stringent in America than in England. In almost all cases, reduction of area is specified at a certain minimum, which in the author's experience was not the case for many English requirements; and the author thinks that Mr. Deschamps will agree that reduction of area represents the one phase of steel casting properties which is very quickly affected deleteriously by slight imperfections, or microscopic inclusions. Based on requirements of tensile strength, elastic limit and elongation percentage, the author is inclined to agree with Mr. Deschamps' opinion that steels are easily made to meet some of the specifications, but very few such specifications exist in American engineering requirements, it being believed, and quite rightly, that reduction of area represents the most revealing characteristic as to the true value of both the material and heat-treatment.

Composite Assemblies

There have been considerable developments in America in the direction of composite assemblies of steel castings and welded parts. In fact, where fabricated construction has replaced cast iron, a new outlet for many steel castings has thus been produced. The second portion of this question, referring to development in the direction of replacing intricate steel castings, by an assembly of plain steel castings later welded together, is more difficult to reply to positively, although the author has seen several cases of this type of production, and has seen it suggested in many cases. He is not aware, however, of very active development along this line.

The substitution of shot-blasting by the use of the hydroblast has been carried out in some quarters, but where steel castings are concerned the reports of its success are not sufficient to justify one in stating future possibilities in this direction.

Mr. Tipper's remarks are appreciated, and the author would assure him that any similarity of statement as pointed out by him is "purely coincidental." The statement made in the Paper that there was no attempt to remove all fines from moulding sand was based on the accepted fact that the control of the percentage of fines at a limit known not to be harmful was the aim, rather than the taking of uneconomic measures to remove them entirely. The author agrees with Mr. Tipper that one should select the right type of sand primarily, but the question arises: What is the right type of sand? It would appear that as the industry's knowledge of the effect of grain size, grain shape, permeability and other moulding-sand characteristics is added to by the many able workers who are giving the results of their work freely to the industry, new ideas as to moulding materials may be produced eventually which may enable the industry to take further forward steps in the improvement of the appearance of steel castings. Such work has been highly productive in the U.S.A., where, in spite of opinions to the contrary held by many Europeans, "skin appeal" represents quite a potent factor in the selling of steel castings.

* See the JOURNAL for August 17 and 24, 1939.

Pomoloy Cast Iron

An unalloyed grey cast iron with a tensile strength of 18 tons per sq. in. and a Brinell of 215 and highly resistant to the corrosive effects of most chemically active waters, has been developed by the Pomona Pump Company, of Pomona, Cal. This iron, which is called Pomoloy, can be hardened by heat-treatment or by an oxy-acetylene process.—"Iron Age."

Efficiency in Crucible Melting*

By G. K. EGGLESTON†

If a crucible furnace were designed to hold a No. 80 crucible, it would have about 25 sq. ft. of outside surface including the cover, and the heat losses from such a furnace with different shell temperatures might be approximately those shown in Table I.

TABLE I.—*Heat Losses from Crucible Shell.*

Shell temp. Deg. C.	Heat lost. B.T.U. per hr.
93	9,100
148	15,000
204	27,000
260	42,500
315	62,500
371	87,500

If the gas input is 500 cub. ft. per hr. at 335 usable B.T.U. per cub. ft., there would be available 167,500 B.T.U. for melting, from which must be deducted the losses from the furnace shell. The percentage this loss is of the available heat and what it amounts to in cub. ft. of gas wasted is shown in Table II.

TABLE II.—*Available Heat Lost and Gas Waste.*

Shell temp. Deg. C.	Available heat lost. Per cent.	Gas waste per cub. ft. per hr.
93	5·4	27
148	9·0	45
204	16·1	80
260	25·0	125
315	37·0	185
371	52·0	260

Insulation

The data of this table indicate the advisability of keeping the furnace shell temperature as low as possible, and the simplest way to do this is to use some type of insulation between the refractory lining and the shell. The amount of insulation necessary will depend upon the refractory brick used; the higher the thermal conductivity, the more insulation necessary. Silicon carbide will require most, magnesium oxide next, then mullite and least of all firebrick.

Unfortunately, a great many of the crucible furnaces now in use were not designed to use insulation and consequently the shells are too small to allow its use without reducing the crucible size. Some foundries have found it profitable to make new shells in order to be able to use the more refractory materials for linings and the necessary insulation they require. While it does not seem to be general practice, it is thought the furnace covers should also be insulated.

Several years ago a foundryman, telling his experience with insulation, said that he was using firebrick linings without any particular difficulty until he tried insulating. When this was done, the lining melted out on about the first heat so he gave it up. If he had stopped to analyse the situation he might have discovered that the reason it melted was because the heat was staying in the brick and increasing its temperature instead of going through it and out the shell. Had the lining held up he would have found the melting time reduced, or if the fuel input was reduced to a point where the lining attained the same temperature as it did before using the insulation, the melting would be done in about the same time but with less fuel.

Heating Experiments

The author carried through several experiments involving furnace temperature, fuel input, and melting time which might serve to illustrate some of the points mentioned. The first step was to determine the maximum furnace temperature obtainable with varying fuel inputs. The figures used for fuel input are only relative and do not refer to any definite standard of measure. Table III gives the maximum furnace temperature obtained over a range of 50 units to 141.5 units. This table shows that tripling the gas input only raised the furnace temperature about 300 deg. C., but the vast difference this 300 deg. C. makes in melting time is shown in Table IV.

TABLE III.—*Maximum Furnace Temperature Related to Fuel Input.*

Gas input. Units per min.	Maximum furnace temp. obtainable. Deg. C.
50·0	1,204
61·3	1,315
70·8	1,360
100·0	1,448
112·0	1,465
122·5	1,482
141·5	1,537

TABLE IV.—*Influence of Gas Input on Melting Time.*

Gas input. Units per min.	Max. furn. temp. Deg. C.	Melting time. Mins.	Gas units used.
50·0 ..	1,204	27	1,350
61·3 ..	1,315	15	920
70·8 ..	1,360	11	780
100·0 ..	1,448	7	700

When the furnace and crucible had reached the maximum temperature for a given fuel input, the crucible was charged and the melting time and fuel input recorded until the charge was melted (1,037 deg. C.). These results appeared so interesting in that a 100 unit input melted four times as fast as the 50 unit, with about one half the fuel consumption, that it was decided to start with a cold furnace, crucible and metal, and bring it up to pouring temperature (1,232 deg. C.), using inputs of 100 units and 61.3 units. This would represent the first heat in the day. These results are shown in Table V.

TABLE V.—*Influence of Fuel Input on Melting Time (First Cast).*

Metal temp. Deg. C.	100 units input.		61·3 units input.	
	Units used.	Time. Mins.	Units used.	Time. Mins.
Melted	2,700	27·0	2,880	46
1,121 ..	2,850	28·5	2,970	48
1,148 ..	2,950	29·5	3,060	50
1,176 ..	3,100	31·0	3,240	52
1,204 ..	3,200	32·0	3,490	55
1,232 ..	3,350	33·0	4,160	57

This again showed that the higher gas input is more economical both as to fuel consumed and the furnace capacity, which was practically doubled. This greater efficiency undoubtedly relates to maintaining a high furnace temperature.

TABLE VI.—*Influence of Fuel Input on Melting Time (Second and Subsequent Casts).*

Metal temp. Deg. C.	100 units input.		61·3 units input.	
	Units used.	Time. Mins.	Units used.	Time. Mins.
Melted	700	7·0	920	14·5
1,121 ..	750	7·5	950	15·0
1,148 ..	850	8·5	1,010	16·0
1,176 ..	900	9·0	1,135	18·0
1,204 ..	950	9·5	1,300	21·0
1,232 ..	1,050	10·5	1,720	27·0

The metal was poured from the crucible after the preceding test, recharged with metal and again brought up to pouring temperature, thus giving the condition that should exist after the first heat is poured (Table VI). Here again the economy of the higher fuel input or furnace temperature is evident to a greater extent than when starting with a cold furnace. The melting time for the 100 unit input is 2.5 times as fast as the 61.3 unit input and the fuel consumption 40 per cent. less.

Experimental Heating Results

The results of this last test (Table VI) illustrate how the rate of metal heating slows down as it approaches the maximum furnace temperature, and the necessity and economy of maintaining high furnace temperature if melting speed or furnace capacity is of importance. In the melting of alloys that are poured around 1,315 deg. C., as required for some of the nickel-silvers, it would be practically impossible to get the metal so hot, using the 61.3 unit input, within several hours. Judging from the results shown, this would be extremely expensive and detrimental to the metal, but still it is being done every day.

The results just described were obtained in the laboratory using a rather small furnace. It is possible that the results obtained from a production-size furnace may not be so striking, but it is only intended to show the effect the different operating conditions may have on the efficiency of the furnace and not the exact magnitude.

Preheating the Air

Another point which should be considered is that of preheating the air used for combustion. This is common practice in several industries but rather the exception in crucible melting. As an illustration—if the gas cited as an illustration in this Paper was burned with air that had previously been heated to 537 deg. C., the flame temperature would be increased from 1,982 to 2,148 deg. C. and the B.T.U. available for melting would increase from 335 to 440, an increase of 34 per cent. If the gas is also preheated, still further increases in flame temperature and B.T.U. content will be obtained.

Adequate heat is being discharged from the furnace to heat the air and gas if properly handled. The original cost of a preheater might be rather expensive but it is thought that it would more than pay for itself in a short time in fuel savings and increased furnace capacity.

Crucible Cost

While fuel is a large item of cost, other items must also be given careful consideration, such as crucible cost. Coke-fired crucible furnaces on the average give the shortest life and resultant high cost. Oil or gas-fired stationary furnaces can give 15 to 20 per cent. more life than coke-fired, and tilting furnaces 35 to 45 per cent. more. The shorter life of crucibles in stationary-type furnaces is due to the mechanical handling.

The open-flame or electric furnaces do not use crucibles, as the metal is in direct contact with the lining of the furnace, but the refractory cost should not exceed that of the crucible cost in the tilting-type crucible furnace. It must be remembered in the case of the tilting crucible furnace, as well as the open-flame and electric, that some type of pouring ladle or crucible must be provided and this item runs into considerable expense.

The author prefers lined ladles in preference to crucibles because of lower cost, also they retain the heat of the metal much better. A crucible is designed to transfer heat rapidly during melting and also gives it off rapidly after being removed from the furnace, causing a very rapid fall in metal temperature during pouring and considerable discomfort to the pourer.

* Extracted from a Paper read before the Cincinnati Convention of the American Foundrymen's Association.

† Metallurgist, Detroit Lubricator Company.

Another item which one cannot afford to overlook is that of metal loss during melting. This point is one of the chief arguments in favour of electric furnaces. Repeated tests run at the author's plant revealed that the metal loss in the electric furnace was consistently less than 0.5 per cent. and in the coke-fired crucible furnace it was never under 2.5 per cent.

Factors Determining Furnace Purchase

What type and size of melting furnaces should be purchased? This question often confronts the foundryman. At least five factors should be taken into consideration: (1) Melting capacity required; (2) number of different alloys melted; (3) fluctuations in production; (4) metal loss; and (5) local fuel costs.

Generally speaking, the most efficient melting can be done in a large furnace when it is run at full capacity, regardless of type of furnace used. This condition would exist only where a foundry runs one type of alloy with a very steady production. If the production of such a foundry decreases, it becomes necessary to operate a large furnace at low capacity which usually is not very efficient. It would be better to divide the melting among several smaller units so that as production decreases a unit can be cut out entirely and the remaining units operated at full capacity.

A small foundry melting a number of different alloys must be able to use the same furnace for several alloys without the danger of contamination. This seems to be accomplished best by the use of crucible furnaces of the stationary type in which it is merely necessary to change the crucible when different alloys are to be melted. A large foundry that could use one furnace for each type of alloy might obtain better economy by using the large tilting crucible, open-flame or electric furnace.

The local fuel prices combined with the other operating costs previously discussed should determine the most economical furnace to buy. There seems to be a tendency to purchase the furnace with the lowest initial cost. This may be the furnace that best meets requirements, but, on the other hand, it might easily be the most expensive to operate, due to inefficient operation, and at the end of the year may cost twice as much as the best furnace on the market. The author believes that the fuel consumption can at least be cut in half, the melting time greatly reduced if not cut in half. Such a furnace should save many shillings per ton on melting cost, and if the proper steps are taken, the metal loss should be reduced comparable with that of electric furnaces. This item alone would pay for a modern furnace in a short time.

It has been the experience of industry that when there is a demand for a product it has generally been supplied, and if foundrymen want better furnaces they can have them, but they must work with the furnace builder, as in most cases he cannot afford to spend hundreds of pounds designing and building a better furnace and then spend several years trying to convince the foundryman that he cannot afford to be without one. This condition should be just reversed—the foundryman should demand and use better and more efficient equipment.

Society of Chemical Industry

It has been decided to vacate the head office of the Society of Chemical Industry for a short time, hoping to return there if it is found that the general conditions while the country is at war would permit work to be carried on efficiently. Meanwhile, until further notice, all official communications should be addressed to the general secretary at 23, Clifton Avenue, Finchley, London, N.3. Editorial communications concerned with "Chemistry and Industry" should be addressed to Dr. S. Miall, 28, Clifton Hill, London, N.W.8. Abstractors should communicate with Mr. T. F. Burton, 39, Richmond Road, Worthing, Sussex.

Gating and Feeding in Steel-Foundry Practice

SOME IMPORTANT PRINCIPLES

By B. RAMASESHIAH*

(1) Broad plain surfaces to be cast in the vertical position, keeping larger width vertical.

(2) Runner to feed direct into flanges.

(3) One of the risers to be placed as near the runner as possible.

(4) Vent openings for all projections to be almost as large as feeder sizes.

(5) Feeders to be placed over core-ends running across flanges.

(6) Runners to be so placed for a circular casting as to be tangential when the circular faces are cast flat.

(7) Rollers with small bosses to be cast edgewise, keeping the riser at the top and cutting the round cod of sand, if any, between the centre boss and rim for forming grooves, so as to give a direct feed into the boss, and also to facilitate the evacuation of gases.

(8) The sizes of the feeders to be always thicker than the sections below on the casting and the bigger dimensions to be at the top.

(9) Feeders to be placed wherever there are T connections of flanges or arms connecting rims, on the outer flanges of rims.

(10) Height of runner always to be higher than that of feeders.

(11) Twin fillets should connect the flat surfaces of the casting and the root of the feeders and well-distributed fillets, at about 6 to 9 in. interval, wherever thicker sections project over flat surfaces having thinner sections.

(12) Direct feeding into the feeders situated near the runners should be practised—a passage to lead hot metal from the runner direct into the feeder at about 3 to 4 in. below the desired top level of the feeder, wherever possible.

(13) Whenever feeders are placed on the flat surfaces, their size must be not less than three times the section of the thickness of the casting.

(14) The runners to be so situated as to permit the metal to run in the direction of flat surfaces in connection with the runners and not at right angles.

(15) Feeders, placed over bosses having central core projections, to taper both inwards and outwards so as to have gradually bigger thicknesses nearer the top of feeders.

(16) Vent feeders or flowers are essential at the places of cored pockets in the casting towards the cope side in the closed mould.

(17) The top surface of the feeder to project higher than the topmost mould surface of the casting—not less than 4 in.

(18) The top surface of the feeder always to be kept covered by heat-insulating and heat-promoting material immediately after the casting of moulds, to prevent immediate formation of top skull due to the radiation of heat.

(19) Thin whistlers must be distributed at the top level of the flat pockets in the cope to lead off gases easily, without forming gas pockets.

(20) Long runner passages connecting two distant points in the casting must not be cut in a straight line, but in a curved or S or zig-zag line to avoid contraction strain on the casting.

(21) Always keep at least two inches of sand thickness in between the risers and bars, or feeders and bars in the moulding box, lest the sand due to heat becomes too hot to permit of contraction and so introduce strain in the casting.

(22) Whenever there is sufficient space between feeders and bars and whenever feeders are situated apart at greater distances in a straight line, it is advisable to create collapsible pockets by ramming a block of wood about 3 in. from the feeders in the mould, removing it, and filling it with loose sawdust and backing with open sand, before the feeder blocks are taken out for finishing.

(23) When running massive castings, fireclay sleeves or burnt firebricks to be chosen for runner passages in preference to sand to avoid sand fusings and washouts.

* Superintendent, General Foundry, Mysore Iron and Steel Works.

Patents and Trade Marks

The Patents, Designs, Copyright and Trade Marks (Emergency) Bill has been read a second time in the House of Commons.

MAJOR LLOYD GEORGE, Parliamentary Secretary to the Board of Trade, in explaining the Bill, said it could be divided into two parts. Clauses 1 to 5 made provision for patented inventions, registered designs, copyright work and, in one special case, registered trade marks belonging to an enemy or enemy subject to be used or produced by non-enemies in this country under licence. The second part extended the limits of time within which certain acts such as the payment of renewal fees had to be done where the doing of an act was prevented by the estate of war, or would injure the person concerned or the public interest.

Clause 1 continued in force the licences held by persons in the United Kingdom at the outbreak of war under enemy-owned patents, subject to compliance with the Trading with the Enemy Act, 1939. Under Clause 1 the Comptroller had the power to revoke or to vary any such licence. Clause 2, which was probably the most important clause in the Bill, gave the Comptroller the power to grant to persons who were not enemies or enemy subjects, licences to use patents, registered designs and so forth in force here and belonging to enemies or enemy subjects. Any royalties accruing as a result of any such action would not go to the enemy patentees, but would be dealt with under the rules applicable to other enemy property in this country.

The same treatment was not appropriate to enemy-owned trade marks, the use of which could not be said to be necessary in the public interest, and if carried on by persons here might lead to confusion. There was, however, a special case where some action was called for, and that was where the enemy-owned trade marks was the only practicable description of the article or substance. It might be that persons here would wish to sell that particular article which was known only under its enemy-owned trade mark, and so in Clause 3 power was given to the Comptroller to suspend the enemy's rights in favour of any person who proposed to make or sell that article here, but only to the extent necessary to enable him to refer to that trade mark until he had established some other name or description of the article.

Clause 4 provided that new patents and registered designs might be granted on applications made by enemies, provided, of course, that the rights so created were subject to the enactments in force relating to enemy property. In other words, patents and registered designs might be granted on these applications, so that licences for their use by non-enemies in the United Kingdom might be granted in accordance with Clause 2. Clause 6 enabled the Comptroller to extend the time laid down in the Patents and Designs Acts and the Trade Marks Acts for the doing of certain acts, where the doing of that act either was prevented by the war or would have been contrary to the interests of the person concerned or to the public interest. That was to say, that if a person was on active service or for other reasons occurring during the war was unable to fulfil his obligations under the Act, the Comptroller had the right to extend the time. The other clauses, Clauses 7 to 11, dealt with the necessary machinery of interpretation and the title of the Bill.

THE WAR OFFICE announces that in order to avoid delay in the despatch and delivery of business correspondence, business firms in the United Kingdom are asked to communicate any change in their normal address to M.C.3, War Department, Box No. 600, S.W.D.O., London, S.W.1.

Making and Application of Industrial Time and Motion Studies*

By W. E. HOLDEN

When looking down through the history of mankind, from the primitive ages to our present highly industrialised state, one is continually impressed by the unceasing attempts made by man to improve the conditions of living of at least a portion of society, if not of society as a whole. In very early times the pace was, for a very long while, extremely slow; with the coming of the Industrial Revolution the tempo of progress towards a better standard of living for the masses began to quicken. History tells a story of many setbacks and many advances towards the goal of the efficient use of materials and energy. One might even venture to assert that if an ideal state could be set up in which the natural resources of materials and energy, including human energy, were used in the most efficient manner possible, Utopia would have been achieved.

During the last fifty years or more industry has ever been on the alert to ensure that material and energy, other than human energy, was used in the most efficient manner. The wasteful use of material is most often very obvious even to the most limited intelligence; the waste of natural energy, while frequently not so evident, at least advertises itself in some manner that can be seen, heard or felt by a human being. A wasteful process must, no matter how slack the control, very soon make itself evident, if in no other manner than by the accumulation of relatively large and visible piles of waste. A hot bearing or sprung joint make themselves very often most unpleasantly and forcibly evident. As these inefficiencies force themselves on one's attention, they are naturally the first to be taken in hand. In other words, to know where wastage is occurring is half-way to preventing it.

To quote Taylor, the father of Time Study:—

"We can see our forests vanishing, our water power going to waste, our soil being carried away by floods; and the end of our coal and our iron is in sight. But our larger wastes of human effort which go on every day through such of our acts as are blundering, ill-directed, or inefficient, are less visible, less tangible, and are but vaguely appreciated.

"Awkward, inefficient or ill-directed movements of men call for an act of memory, an effort of the imagination, for their appreciation. For this reason, even though our daily loss from this source is far greater than from the loss of material things, the one moves us to righteous indignation, the other passes largely unseen, even unsuspected."

To slow up and eradicate this cancer gnawing at the vitals of our industrial efficiency is the aim of Motion and Time Study.

History of Time and Motion Study

The industrial Time Study was originated by F. W. Taylor, who came from a well-to-do Philadelphia family, and studied to enter Harvard with notable success, but at the cost of seriously impaired eyesight. Forced to give up the idea of further study, he was appointed as a machinist and patternmaker. At the age of twenty-two, in 1878, when conditions were bad, he was obliged to enter the machine shop of the Midvale Steel Works as a labourer. Taylor's subsequent history makes interesting reading. Suffice it to say that he always retained an inquiring mind and the faculty of analytical reasoning, and as promotion came to him the opportunities of saving human energy and time were more and more impressed on his mind. In due course, he prevailed on the authorities to support him in a series of investigations which are now known as the first scientific Time Studies.

Taylor stated many times that scientific management required a complete mental revolution on the part of the workman—and on the part of those on the management's side. Both parties must recognise as essential the substitution of exact scientific investigation and knowledge for the old individual judgment or opinion. Taylor's genius was that he approached problems which had been thought either not to exist, or to be easily solved by common sense, in a spirit of scientific inquiry.

The study of motion in a scientific manner was largely the outcome of work done by F. B. Gilbreth and his wife, T. M. Gilbreth. Industry owes them a great debt for pioneering work in this field. Principles and techniques which they developed years ago are being adopted by industry to-day at an increasingly rapid rate.

Gilbreth began his industrial career in the building trade by learning the bricklayer's trade. He rose rapidly and was soon in the contracting business himself. He was struck very early by the different motions adopted not only by different workmen to perform the same operation, but also by the same workman when working fast and when working slowly. He came to the conclusion that to perform each of the many thousands of series of movements in each particular trade, there was only one series of movements in each case and one succession of these movements that lead to the most efficient use of time and human energy.

During the course of time Gilbreth was able, by the use of the motion-picture camera and a timing device, to undertake an intensive study of each element of motion made during any operation. The permanent record on the film made comparisons with other methods easily possible, and hence the best and quickest series of motions could easily be established.

Another instrument Gilbreth used was what is now known as a Chronocyclegraph. This enables a record to be made of the motion of an operator in three dimensions. A small electric light bulb is attached to the finger or any other part of the body to be studied, and the path of light is then photographed with a stereoscopic camera. If an interrupter is placed in the electric circuit with the bulb, and if the light is flashed on quickly and off slowly, the path of the bulb will appear as a dotted line with pear-shaped dots indicating the direction of the motion. The spots of light will be spaced according to the speed of the movement, being widely spaced when the operator moves fast and close together when the operator moves slowly. From this graph it is possible to measure accurately time, speed, acceleration and retardation; and the picture of this motion in three dimensions is called a Chronocyclegraph.

Definition of Motion and Time Study

The terms Motion and Time Study have been given many interpretations since their origin. Time Study originated by Taylor was mainly used for rate setting, and Motion Study, developed by the Gilbreths, was largely employed for improving methods. Modern practice requires that Motion and Time Study be used together since the two supplement each other. In the following remarks, the term Time Study will be used in its widest sense to embrace the idea of Motion Study.

Motion and Time Study may be defined as an analysis of the methods, the materials and the tools and equipment used in the performance of a piece of work. Taylor, the originator of Time Studies, gave the following as a definition of Time Study (notice the wide sense in which the term Time Study is used to embrace Motion Study). "Time Study is the one element in scientific management beyond all others making possible the transfer of skill from management to men."

Time Study consists of two broad divisions, first analytical work, and second constructive work. The analytical work of Time Studies is as follows:—

(*a*) Divide the work of a man performing any job into simple elementary movements.

(*b*) Pick out all useless movements and discard them.

(*c*) Study one after the other, just how each of several skilled workmen makes each elementary movement, and with the aid of a stop-watch select the quickest and best method of making each elementary movement known in the trade.

(*d*) Describe, record and index each elementary movement with its proper time so that it can be quickly found.

(*e*) Study and record the percentage which must be added to the actual working time of a good workman to cover unavoidable delays, interruptions, minor accidents, etc.

(*f*) Study and record the percentage which must be added to cover the newness of a good workman to a job, the first few times he does it.

(*g*) Study and record the percentage of time that must be allowed for rest and the intervals at which the rest must be taken, in order to offset physical fatigue.

The constructive work of Time Study is:—

(*h*) Add together into various groups such combinations of elementary movements as are frequently used in the same sequence in the trade, and record and index these groups so that they can easily be found.

(*i*) From these several records, it is comparatively easy to select the proper series of motions which should be used by a workman in making any particular article, and by summing the times of these movements and adding proper percentage allowances, to find the proper time for doing almost any class of work.

(*j*) The analysis of a piece of work into its elements almost always reveals the fact that many of the conditions surrounding and accompanying the work are defective.

Use and Aims of Time and Motion Study

The uses of Time and Motion Study will be briefly discussed under the following headings:—(1) Improving output rates; (2) wage incentives; (3) costing; (4) estimating costs of new products, and (5) economics of new or modified plant.

Improving Output Rates

Whenever a certain operation or series of operations has to be repeated a great number of times by an operator, either in assembling parts or in making certain parts of a machine or article, there is always what is called "the one best way" of doing the job. A trained analyst who is not directly connected with the organisation in which the study is being made can best study the problem, as he is free from other worries and distractions common to all shop foremen and superintendents.

The means taken to study the job under consideration are many and varied; suffice it to say that the analyst will endeavour to eliminate all useless and inefficient motions. Movements requiring relatively long periods will be studied with a view to reducing the time taken. The determination of the element occupying the longest time for its performance is one of the major aims of the Time Study. In the case

* Paper read before the South African Branch of the Institute of British Foundrymen through the courtesy of the management of Iscor and the Iscor Efficiency Bureau.

of a single operator making or assembling parts of a machine this "long time element" is often the first one to be attacked as it naturally affords the greatest opportunities for improvement.

When timing complete and continuous processes, more especially processes where the flow of material must necessarily be constant and no accumulation of material must occur at any point (*e.g.*, a steel rolling mill, where any one piece of steel cannot be left lying for any length of time as it would cool off and require reheating or have to be scrapped), the determination of the element taking the longest time is of paramount importance, as on this time the whole production rate depends. The longest time element in this case is suitably termed the "bottleneck." This might be restriction in the supply of material, limited crane service, inadequate sand supplies, etc. If the output rate is unsatisfactory it is obvious that a general tightening-up over the the various elements will be useless unless the time in the bottleneck can be reduced.

In a complex process such as foundry practice the bottleneck, although of paramount importance, is not always evident from a casual survey. The stop-watch points with unerring accuracy to that process on which the rate of all other processes depends. Increased production rates can only be realised if the time in the bottleneck can be reduced. It is often amazing what steps will be taken to increase output rates which prove to have no beneficial effect whatsoever, solely because the improvement made cannot be used, as the true bottleneck has been completely overlooked. Once the bottleneck is definitely established, steps can be considered to lessen the restrictions it imposes.

Considering another aspect, Time Studies frequently show up wastage of time. One finds that a production rate is slower than it should be, not because of any deliberate action on the part of the individual or crew concerned, but because they, lacking the tool called Time Study, are ignorant of the possibilities of the plant they are operating. It may sound like a platitude to say that many plants are working from ten to twenty per cent. under their optimum output, simply because the optimum production has never been scientifically determined and laid down for each of the various products manufactured. Humans are very prone to place absolute faith in previous best figures or what appear to be good figures as criteria by which all effort must be judged. When Time Study figures are placed before them giving convincing proof that rates of production can be increased above the accepted level, they are very sceptical and refuse to believe facts. In such cases a policy of letting time prove the scientific study right or wrong is the only one to be adopted; time sooner or later in ninety-nine cases out of a hundred proves the Time Study correct to within a very small margin.

Another real advantage of knowing what a machine or plant can do, in spite of many records quoted to the contrary, is that the operator or operators can be given a printed form on which the time taken for a given operation is set down, or in the case of a complete plant a form showing the number of units to be handled per hour and the sequence time called for between units. Thus the men actually doing the job can see from hour to hour right through the shift whether they are keeping up a satisfactory pace or whether they are lagging behind. This publishing of rates or sequence times has the effect of spurring a bad or inexperienced operator to greater efforts and of giving the good operator the satisfaction of knowing that he is well up to, if not above, a good recognised standard.

It often happens that the analyst is struck by awkward or difficult movements, which, if eliminated, would greatly reduce the stress experienced by the operator. A rearrangement of the various tools and material, the substitution of power-driven tools for hand tools, better illumination, etc., are all factors to be taken into account when taking and working up the Study.

Once the best way of doing any particular job has been settled, it is imperative that each tool, movement, etc., be carefully standardised and a detailed written record made in order to ensure that the accepted standard is rigidly observed. It may be necessary in certain cases to train the operators in the new methods. In America special classes for training groups of operators by means of motion pictures and lectures have been set up.

Wage Incentives

Having standardised the "one best way" to perform any operation or series of operations and having determined in a scientific and accurate manner a fair rate of working, the designing of a wage incentive scheme becomes a comparatively simple matter. A system can be worked out which not only enables the average workman to obtain a fair and equitable return for his labours, but which also makes provision for any individual who may happen to possess naturally inherent capabilities in certain directions to exploit these capabilities for his own betterment.

Costing Purposes

The outputs based on Time Studies are frequently very useful for determining the costs of particular products. For instance, the expenditure on any section of a plant over a period may be known, but the split of this expenditure over the different products treated, or manufactured, in the plant may not be completely known. It may be known that certain items of the expenditure are constant per unit for all types of products, but other items may vary according to production rates. The split of expenditure on these items over the various products may easily be made by using output rates based on Time Studies, splitting the expenditure over the products concerned in the ratio of their relative rates.

Estimating Costs of New Products

In industry it is frequently imperative to know beforehand what certain products will cost if produced. Very often the availability of a means of making reasonably accurate and reliable estimates makes all the difference between a success and failure. In foundry work, for instance, experienced foundrymen can estimate fairly accurately the amount of material that will be required to make a certain casting. The estimate of the moulder hours, etc., that will be required is much more difficult, and would probably be more a matter of opinion. This is especially the case when a large number of small castings are to be made.

Time Studies taken in the foundry over a period of time would prove a tremendous help in this connection. With proper indexing, the time required to make similar jobs or parts of jobs can readily be found and used as a basis on which to make the new estimate. Thus not only do Time Studies assist the costing of current products, but they are also invaluable when tendering for new types of work on a large scale. It is surprising, when considering all the variables involved, how accurate this method is when compared with the actual costs incurred when the product is eventually produced.

Economics of New Plant or Modified Plant

It frequently happens that questions of installing new plant or modifying existing plant are raised. It is often a very vexed question to decide whether the new plant is justified or not. The purpose of the alterations or additions is usually to speed up production or to avoid unnecessary waste. A Time Study can very often show the extent to which production is being held up, and thus the saving to be gained can easily be computed. As the Time Study is based on absolute facts, the persons who have to shoulder the responsibility of making the decision are not compelled to rely on someone's opinion, however good (or bad) it may be, but can scan the facts and check the deductions for themselves.

For example, it may be thought that the crane service is inadequate and is causing loss of production time. In the first place, a Time Study will prove whether the service was actually inadequate or not, or whether a reorganisation in the succession of operations and layout of the work would solve the problem. If the service proved inadequate, a fair estimate could be made of the time that would be saved, from which basis the economics of installing further capacity could be considered. The same applies to almost any type of new plant.

(To be concluded.)

Publications Received

Brief Subject and Author Index of Papers in the Proceedings, 1847-1938. Published by the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.

It is interesting to record that after lapses usually spanning a decade, the Institution has in recent years been turning its attention to the study of what is, after all, its principal raw material. These indices serve a very useful purpose by setting out readily-consulted sources of information on engineering subjects. Mechanical engineering is *per se* such a wide subject that it is only natural that, throughout the years, other institutes have been formed to study some particular section, but in general, as this index shows, there has been made a well-balanced effort to cover practically every phase of mechanical engineering.—V.C.F.

Handbook of Information, including Annual Report 1938-1939, Indexed Lists of British Standards and B.S. Methods of Tests. Published by the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 1s. 6d.

Every issue of this extremely useful handbook shows that increasing attention is being given to the products of the foundry industry, there now being no fewer than 36 types of casting (including metal for castings) covered by specifications. The first section which the reader invariably consults is that which lists the new and revised British Standards in course of preparation. Those interested in the following subjects should see that their views are being represented to the appropriate committees: Brass taps and waste fittings; light alloy castings (many of the specifications are being revised, including 3L5, 3L8, 4L11, 2L24 and L33); test codes for crucible furnaces; direct-fired continuous drying ovens and other types of gas-fired furnaces; malleable iron castings, both blackheart and whiteheart (revisions of Nos. 309 and 310 of 1927); cast-iron columns for street lighting; steel castings for ships, marine engines and general engineering purposes (revision of several specifications), and cast-iron flue or smoke pipes (revision of No. 41 of 1908).

IN THE half-yearly report of the General Ironfitters' Association, issued from Falkirk, it is stated that, in the engineering section, trade remained exceptionally busy throughout the half-year, overtime being general.

SHALAGO (highest in Carbon)
COAL DUST
PARTING POWDER
TERRA FLAKE
BLACKLEAD and
FOUNDRY REQUISITES

•

The Cumming
FURNACE
Melts Brass in 15 minutes

•

The Cumming
HAND RAM
MOULDING MACHINE

•

The Cumming
ELECTRIC RIDDLE

•

Head Office and Works—
KELVINVALE MILLS,
MARYHILL, GLASGOW.

FOUNDRY BLACKINGS

•

PLUMBAGO
IMPORTED DIRECT FROM CEYLON

•

CUMMING CORE
COMPOUNDS

•

CORE GUM
CUMMINGUM

•

WM. CUMMING
AND COMPANY LIMITED
IRONFOUNDERS' FACINGS MANUFACTURERS & GENERAL FOUNDRY FURNISHERS

Branches at
FALKIRK, CHESTERFIELD, DEEPFIELDS AND MIDDLESBROUGH.
LONDON OFFICE: 26, COLLEGE DRIVE, RUISLIP, MIDDLESEX.
PHONE: RUISLIP 2390

The Week's News in Brief

Trade Talk

T. S. WILSON & COMPANY, plumbago, graphite and blacklead importers, have transferred their offices to 96, Burnham Road, Leigh-on-Sea, Essex.

UNTIL FURTHER NOTICE the address of Stein & Atkinson, Limited, will be 47, Wolsey Road, East Molesey, Surrey.

MACNAB & COMPANY, LIMITED, foundry equipment specialists, have removed from 150, Holborn, London, E.C.1, to 14, St. John's Road, Harrow, Middlesex (telephone Harrow 1202).

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION announces that the annual dinner arranged for Thursday, November 16, has been cancelled.

BORAX & CHEMICALS, LIMITED, have acquired emergency accommodation at "Batchelors," North Waltham, near Winchester, Hants. The telephone number is Dummer 39.

THE DEPARTMENT OF OVERSEAS TRADE announces that the British Industries Fair, which was to have been held in London and Birmingham in February, 1940, is cancelled.

AT THE last meeting of the Council of the British Cast Iron Research Association, the firm of Andersons, Limited, of Christchurch, New Zealand, was elected to membership.

G. A. HARVEY & COMPANY (LONDON), LIMITED, are closing their West End offices at 58, Victoria Street, London, S.W.1, and transferring the staff to their works at Woolwich Road, London, S.E.7, to which address all communications should be sent.

A MEMBERSHIP of more than 12,000 has been attained by the United Patternmakers' Association. The executive has been given discretionary powers to invest another £20,000 of the surplus funds.

THE STATUTORY AUTUMN MEETING of the Iron and Steel Institute will be held on Thursday, November 23, 1939, at 3.30 p.m. at the offices of the Institute, 4, Grosvenor Gardens, London, S.W.1. No Papers will be read or discussed; only formal business will be transacted.

THE GENERAL ELECTRIC COMPANY, LIMITED, informs us that the Osram Companies referred to in the list of enemy concerns are subsidiaries of the Osram G.m.b.H., of Berlin, and have no connection of any kind whatsoever, financial or otherwise, with the G.E.C. The well-known Osram lamps and valves are made in England entirely out of British and Empire materials. The Osram trade mark for Great Britain and the British Empire is owned exclusively by the G.E.C., which is itself an entirely British company under British control.

GLASGOW CORPORATION intends to place orders almost immediately for 130 new buses—30 of single-deck type and 100 of double-deck type—at a cost of more than £150,000. The Transport Committee have recommended that 30 single-deck chassis be ordered from Associated Equipment Company, Limited, London; 50 chassis for double-deckers from Albion Motor Company, Limited, Scotstoun, Glasgow, and 50 from A.E.C., Limited; 80 double-deck bodies and 30 single-deck bodies from Metropolitan-Cammell-Weymann Company, Limited, and 20 double-deck bodies from R. Y. Pickering & Company, Wishaw.

A WAR-TIME measure for the dilution of labour which will affect several thousand foundrymen in the West Wales area was agreed to in principle by delegates representing unions associated with the Welsh Engineers and Founders' Conciliation Board when they met at Swansea. It was decided that each works should make individual arrangements in regard to an earlier start to meet A.R.P. needs, while each union will discuss arrangements with employers according to their own circumstances. It was also announced that from next month overtime would be at the rate of time-and-a-half instead of starting at time-and-a-quarter for the first two hours.

SIEMENS-SCHUCKERT (GREAT BRITAIN), LIMITED, as announced last week, has severed all connection with Germany, and is now entirely under British direction. Chairman of the board of directors is Mr. Henry Morgan, who is also chairman of the London Chamber of Commerce. Mr. A. White has joined the board, and has been appointed managing director *pro tem* in order to effect the necessary measures of reorganisation. The company will continue the manufacture, among other products, of electricity meters at its Park Royal Works, and flameproof coal-drilling equipments at its Brentford Works.

THE COMMITTEE of the International Building Club extends an invitation to everybody associated with any branch of the building industry to make full use of the Club premises of 141, Park Lane, London, W.1, for the duration of the war. The Club will continue to provide the facilities that have been available to members in peace time. The Committee feel, however, that at a time like this, when there is a danger of businesses, trades and professions being disorganised, the Club at least can play some small part in linking together the members of the building industry, and any readers will therefore be welcome to visit the Club at any time with their guests and friends and to consider themselves as Honorary Members of the Club for the period of hostilities.

THE Sheffield Metallurgical Association announce that it has been decided that it will be necessary to modify the usual winter lecture programme and the opening hours of the Sheffield Metallurgical Club for the present. Arrangements have been made for the club premises to be open on Tuesday evenings from 5.30 till 8 p.m. and on Saturday afternoons from 12.30 till 3 p.m., so that members may meet for the discussion of mutual problems. It is the wish of the Council to resume the normal activities of the Association at the earliest opportunity, and although the lecture programme has been cancelled for the time being, it is hoped to arrange meetings for the informal discussion of outstanding metallurgical problems as soon as conditions permit.

Obituary

THE DEATH has occurred of Mr. John Mitchell White, a director of the Cork Iron & Hardware Company, Limited, and a prominent figure in the commercial life of Southern Ireland.

THE DEATH has occurred of Mr. William Boyd, for many years prominent in the West of Scotland Association of Foreman Engineers. He was associated with Hydepark Locomotive Works for nearly 50 years, and was head of the patternshop for many years. He retired about six years ago.

MR. SYDNEY EVERSHED, who founded with Mr. E. B. Vignoles the electrical instrument making company of Evershed & Vignoles, Limited, died suddenly last week. He had been associated with the manufacture of electrical testing instruments for over half a century, and was particularly associated with the development of instruments for testing electrical insulation.

Reports and Dividends

British Aluminium Company, Limited—Interim dividend of 4 per cent.

Craven Bros. (Manchester), Limited—Interim dividend of 7½ per cent.

Range Boilers, Limited—Half-yearly dividend on the 6 per cent. cumulative preference shares.

Imperial Chemical Industries, Limited—Interim dividend of 3 per cent. on account of 1939.

Wolverhampton Die-Casting Company, Limited—Dividend of 12½ per cent. for the year ended June 30.

Cochran & Company, Annan, Limited—Net profit for the year ended June 30 last, £17,005; brought in, £1,521; dividend of 7½ per cent., tax free; written off a trade investment, £2,000; transferred to reserve, £5,000; carried forward, £618. Meeting, October 24.

W. H. Dorman & Company, Limited—Net profit for the year to March 31 last, after charging working and administration expenses, interest, maintenance and depreciation and removal expenses, £21,125; brought in, £20,067; to general reserve, £15,000; dividend on the preference shares of 11 per cent., £13,750; dividend of 12½ per cent. on the ordinary shares, £3,687; carried forward, £8,755.

Personal

MR. JOHN CRAIG, C.B.E., has been nominated President-Elect by the Council of the Iron and Steel Institute.

DR. W. F. CHUBB, B.Sc., has been appointed consulting metallurgist at the Ontario Research Foundation, Toronto, Canada.

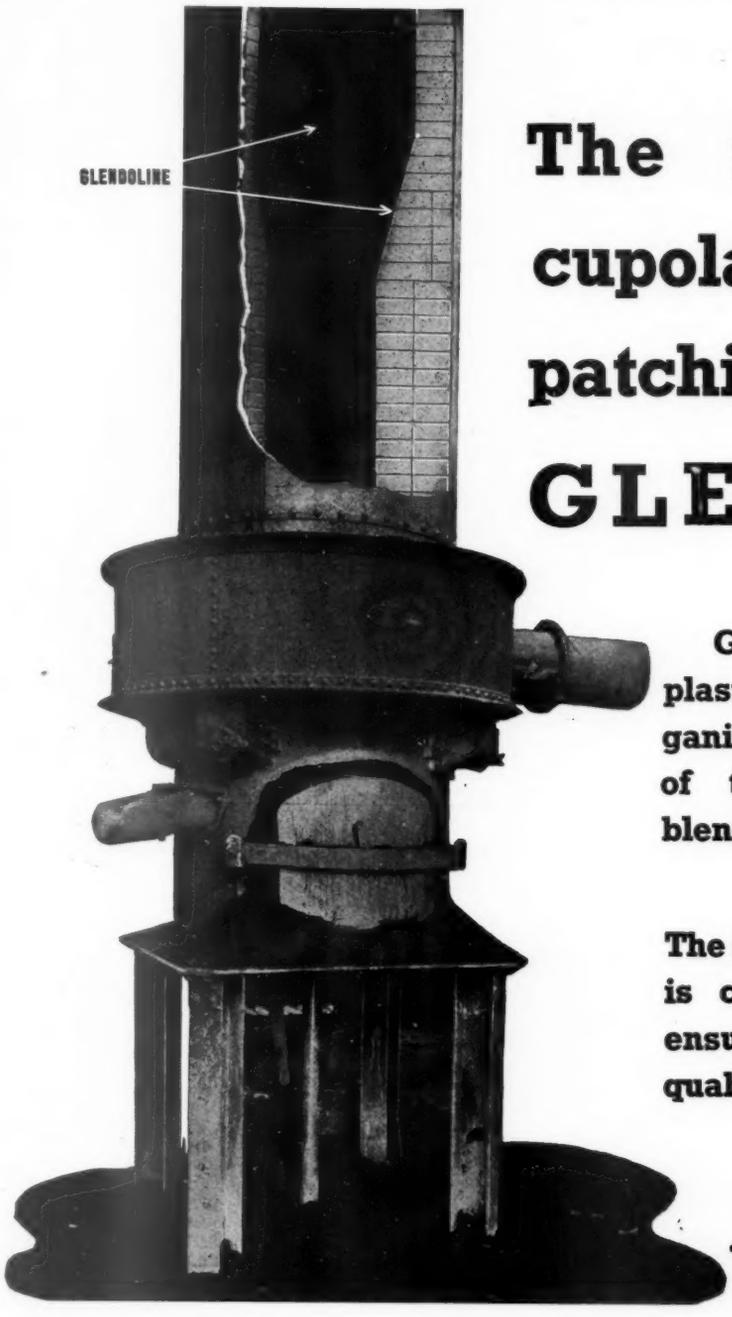
MR. W. H. HOWDEN, of James Howden & Company, Limited, Glasgow, has been elected Deacon of the Incorporation of Hammermen, with Mr. Walter Macfarlane, of Walter Macfarlane & Company, Limited, Saracen Foundry, Glasgow, as collector.

A Metallurgical Puzzle

In an article circulated to the technical Press by Mr. J. F. Lincoln, the chairman of the Lincoln Electric Company, Limited, of Welwyn Garden City, there are included two tables of tensile tests taken from test pieces made by fourteen inexperienced men in the class of the school of the Lincoln Electric Company. These tests on all-weld metal spread over six weeks yielded an almost uniform average tensile strength of 29 tons per sq. in. This figure was associated with much lower elongations in the morning session than in the afternoon, the actual averages being 23.3 per cent. for the morning session and 30.1 per cent. for the afternoon. It would be interesting to learn what a night shift would yield!

R. J. RICHARDSON & SONS, LTD.
COMMERCIAL STREET, BIRMINGHAM, 1
Airless and Pressure Blast Cleaning Plants
AIR COMPRESSORS
DUST ARRESTERS
CHILLED IRON SHOT—BLASTYTE
FOUNDRY EQUIPMENT
WE SHOT OR SAND-BLAST FOR ALL TRADES
Telephone: MIDLAND 2281 & 2282.

MAGNETIC SEPARATORS for the Foundry
"RAPID-BIAFLUX" (Patent) PULLEYS & DRUMS
The Popular "OVERBAND" LISTED IN 5 SIZES
LIFTING MAGNETS FOR PIG IRON & SCRAP
THE RAPID MAGNETTING MACHINE CO. LTD.
MAGNET WORKS, LOMBARD ST.
BIRMINGHAM, 12



The ideal cupola lining and patching material . . .

GLENDOLINE

Glendoline is a carefully prepared plastic refractory, comprising ganister stone from a selected bed of the famous Sheffield quality, blended with a special clay.

The mixing and grading of Glendoline is controlled to a definite formula, ensuring dependable and uniform quality.

★ EXTREMELY PLASTIC

★ HIGHLY REFRACTORY

★ GREAT MECHANICAL STRENGTH

★ This photograph of a cupola, shows a portion of the lining and the positions where Glendoline is recommended for lining and patching.

Please write for full information and descriptive leaflet to :—

GENERAL REFRACTORIES Ltd.

Telephone : *Sheffield* 31113 (6 *lines*). **GENEFAX HOUSE, SHEFFIELD** *Telegrams :* *"Genefax, Sheffield."*

Raw Material Markets

The Minister of Supply has made an Order dated September 22 (the Control of Iron and Steel (No. 2) Order, 1939) regulating the sale and purchase of iron and steel and fixing maximum prices for a range of iron and steel products in substitution for the Control of Iron and Steel Order, 1939, of September 1, which is repealed. Apart from certain changes of form, the Order repeats the provisions of the previous Order in regard to the restriction of the purchase or sale of iron and steel except under licence, and the schedule of maximum prices remains unaltered. A new provision is included enabling the Minister to call for returns and information in regard to stocks of iron or steel and the businesses of firms engaged in the production, merchanting and consumption of any of the controlled materials.

The Minister has also issued a direction under the new Order exempting from the requirement of a licence the purchase of some of the controlled materials by certain persons and undertakings for specific purposes. This direction replaces the notice issued under the former Order. In addition to exempting from licence the purchase of manganese ore for the purpose of manufacturing chemicals, electric batteries, manganese metals, glass or ceramics, it extends the list of customers by whom and purposes for which materials may be purchased without licence. A new exception is made in regard to high-speed steel containing more than 14 per cent. of tungsten in all forms, for which a licence will in future be required for all transactions. The Minister has also issued an order fixing maximum prices for iron and steel scrap.

There is every indication that the iron and steel industry is quickly becoming acclimatised to the new conditions brought about by the introduction of State control. In a recent broadcast speech, Sir Samuel Hoare, Lord Privy Seal, stated that "you cannot pass from peace industry into war production without dislocation," but in this instance it seems that the period of transition will be of shorter duration than might well have been expected. This is indicative of the realisation by all concerned of the essential nature of the plans now being put into effective operation to ensure an adequate supply of iron and steel to meet the increased demands which will be experienced during the period of hostilities. The needs of ordinary commercial consumers will be given every consideration, and it is hoped that these will be met with increasing expedition, but in the meantime users will no doubt accept any delays philosophically.

Scrap Under Control

Prices of foundry cast-iron scrap have now been brought under control, and maximum prices have been fixed for the various grades. Hitherto, only steelworks' scrap has been subject to price control, but it has been recognised for some time that prices of foundry scrap, if not supplies, would eventually be subject to regulation. For the time being, no licence is required to acquire iron and steel scrap, though the authorities have taken power to impose control.

The Control of Iron and Steel (No. 3) Scrap Order, 1939, dated September 22, prohibits the sale or purchase of scrap iron and scrap steel except under licence, and fixes maximum prices for a wide range of classes of scrap iron and steel used in the industry. It also provides that the Minister may require returns and other information relating to stocks of scrap iron and steel and the business of merchants and consumers thereof. Under a direction issued simultaneously by the Minister under this Order, however, the purchase and sale of scrap iron and steel is exempted for the time being from the requirement of a licence, save that special scrap steel of low sulphur and phosphorus content, high-speed scrap steel containing 14 per cent. or more of tungsten, scrap steel containing 1½ per cent. or more of nickel and shipbuilding iron and steel scrap, may not be purchased by or sold to iron and steel works, foundries and forges without a licence.

TABLE I.—*Maximum Prices per ton for Scrap Iron and Steel for Use for Iron and Steel Foundry Castings.*

For Consumers in	Specification No.							
	1	2	3	4	5	6	7	8
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Scotland	70 9	68 3	—	83 0	78 0	83 0	66 0	61 0
Northumberland and Durham, inc. Middlesbrough	68 3	66 0	—	80 6	75 9	78 0	66 0	61 0
Cumberland, Westmorland and Lancashire	70 9	68 3	—	73 3	68 3	68 3	61 0	56 0
West and North Ridings of Yorkshire	73 3	70 9	107 3	75 9	70 9	70 9	66 0	61 0
East Riding of Yorkshire	70 9	68 3	—	78 0	75 9	78 0	66 0	61 0
Derby, Notts and Lincs	73 3	70 9	107 3	75 9	73 3	73 3	66 0	61 0
Chesh, Anglesey, Caernarvan, Denbigh, Flints, Merioneth, Montgomery, and Radnorshire	66 0	63 6	—	73 3	68 3	68 3	58 6	53 9
Salop, Staffs., Worcester and Warwick	68 3	63 6	100 0	78 0	73 3	73 3	66 0	61 0
Leics., Northants, Cambridge, Huntingdon and Rutland	70 9	68 3	—	80 6	75 9	78 0	66 0	61 0
Norfolk and Suffolk	70 9	68 3	—	73 3	68 3	73 3	58 6	53 9
Cardigan, Brecknock, Carmarthen, Pembroke, Glamorgan, Monmouth, Hereford and Gloucester	70 9	68 3	—	75 9	70 9	75 9	67 0	62 3
Somerset, Dorset, Wilts, Hampshire and Sussex	66 0	63 6	—	75 9	70 9	70 9	61 0	56 3
Oxford, Berks and Beds	66 0	63 6	—	78 0	73 3	73 3	66 0	61 0
Essex and Kent	66 0	63 6	—	78 0	73 3	73 3	66 0	61 0
County of London	66 0	63 6	—	73 3	68 3	68 3	61 0	56 3
Middlesex, Surrey, Hertford and Bucks	70 9	68 3	—	75 9	70 9	70 9	63 6	58 6
Cornwall and Devon	66 0	63 6	—	66 0	61 0	—	51 3	46 6
Northern Ireland	—	—	—	75 6	70 9	—	58 6	53 6

Maximum Prices

The maximum prices per ton which have been laid down for scrap iron and steel for use for iron and steel foundry castings are given in the accompanying table. Specifications are as follow:—

1.—Short, heavy-steel scrap, consisting exclusively of rails, railway tyres and fishplates in 18-in. to 24-in. lengths (if scrap is required in less than 18-in. lengths, an extra of 2s. 6d. per ton for cutting may be paid).

2.—Short, heavy-steel scrap, consisting of shearings, bar ends and constructional scrap, not less than ¼ in. thick and in 18-in. to 24-in. lengths (if scrap is required in less than 18-in. lengths, an extra of 2s. 6d. for cutting may be paid).

3.—Hematite ingot mould scrap, in cupola sizes.

4.—Heavy machinery cast-iron scrap, in cupola sizes.

5.—Ordinary heavy cast-iron scrap, not less than ½ in. thick, in cupola sizes.

6.—Cast-iron railway chairs.

7.—Medium cast-iron scrap, consisting of gas stove plate, wringers and similar in cupola sizes.

8.—Light cast-iron scrap, in cupola sizes.

Quantity Premiums

The list prices are based upon the scrap being clean and to specification in accordance with the custom of the trade, otherwise a proper allowance must be made, and on deliveries free to consumers' works; other forms of delivery shall be in proper relation thereto.

Where delivery of scrap of any one specification under an order (*a*) for 50 tons and upwards but less than 100 tons is tendered within three months, or (*b*) for 100 tons and upwards is tendered at the rate of not less than 50 tons but less than 100 tons per three months, the list prices shall be increased by 6d. per ton.

Where delivery of scrap of any one specification under an order (*a*) for 100 tons and upwards but less than 250 tons is tendered within three months, or (*b*) for 250 tons and upwards is tendered at the rate of not less than 100 tons but less than 250 tons per three months, the list prices shall be increased by 1s. 6d. per ton.

Where delivery of scrap of any one specification under an order of 250 tons and upwards is tendered at the rate of not less than 250 tons per three months the list prices shall be increased by 2s. 6d. per ton.

To all the list prices 2½ per cent. shall be added in the case of sales by *bona fide* scrap iron and steel merchants carrying on business as such at the date of the order.

Metals

The Minister of Supply has issued the Control of Non-Ferrous Metals (No. 3) Order, 1939. It repeals and replaces Article I of the Control of Non-Ferrous Metals Order, 1939, which, subject to certain exceptions, prohibited the sale to or purchase by a consumer of copper, lead or zinc except under licence. The new Order extends this provision to cover all sales and purchases, whether to consumers or not. At the same time, the Minister has issued a direction under the new Order which takes the place of the exceptions embodied in the previous Order exempting from the requirement of a licence (*a*) the sale and purchase of any copper, lead or zinc in quantities of less than 1 ton in each case for the execution of urgently needed repairs; (*b*) the performance of contracts entered into before September 1, 1939, where the price payable under such contract was fixed and ascertained before September 1, and (*c*) the sale and purchase of scrap copper, lead and zinc, for the purpose of cleaning, grading or crushing with a view to resale.

Representatives of the Ministry of Supply on Monday met a committee of the London Metal Exchange and later entered into discussion with a full meeting of the Exchange. These meetings followed representations which had been made to the Government on the question of the rigid control of the market. It is now understood that the Government will make certain adjustments in the current system. Metal dealers had pointed out, among other things, that the maximum prices for copper, lead and zinc made no allowance for dealers' commissions; traders in tin are not allowed to resell at a substantial profit in the United States metal bought in London at about £230, which was a practice indulged in by American concerns; the cost of the Government stock insurance scheme could not be passed on to the consumers.

Following the representations to the Ministry, it is now believed that dealers will receive an allowance in respect of contracts with customers. The Ministry is expected to supply metal for dealers at a slightly cheaper rate than that charged for direct sales to consumers. With regard to tin, London traders are to be permitted to sell to the United States at over £230 per ton, a stipulation being that the premium should be kept within a reasonable limit. Negotiations are stated to be in hand for the Government to take over dealers' stocks together with the insurance risks, although firms desiring to retain supplies will be permitted to do so.

Metal dealers also pointed out to the Ministry of Supply that the levels at which prices have been fixed are too low, but the Ministry stated in reply that when the immediate post-war buying movement has subsided metal prices in the United States and elsewhere should return nearer to the British level.